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PHYSICAL GROWTH FROM BIRTH TO TWO YEARS: II. HEAD CIRCUMFERENCE

PART I. A REVIEW AND SYNTHESIS OF NORTH AMERICAN RESEARCH ON GROUPS OF INFANTS

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A few years ago the writer began a series of studies intended to aggregate and systematize the available research materials on selected items of physical growth during infancy. The first of these studies dealt with stature, and was published as a monograph (20). The second treats head circumference, and has been prepared in the form of two papers.

The present paper - the first of the two on head circumference - presents a colligation of North American research to date for groups of infants. Its companion paper, to be published later, will bring together the studies made in North America on the growth of individuals. Readers should recognize that this division is merely a convenient device for reducing the problem to articles of journal length.

In its scope, then, the present paper is restricted anthropometrically to girth of the head (occipito-frontal circumference), chronologically to the first two postnatal years, geographically to North America, secularly to the period from 1850 to 1945 (all of the presently accessible data having been collected between these dates), and analytically to the study of groups. These delimitations should be kept in mind; they constitute the frame of reference within which the contents of the paper are written and its conclusions claimed to hold.

The organization of the paper is bipartite. First, the source materials are reviewed. Succinct presentation is made of the relevant problems, procedures, and findings from thirty-five North American investigations reported between 1853 and 1945. Three of these investigations were executed prior to 1900, twelve in the period from 1900 to 1925, and the remainder during the ensuing two decades. In six instances, source materials are drawn from previously unpublished studies. Secondly, the source materials are synthesized. Here, the major objectives are to integrate information on infant head girth (the information which has accrued from statistical study of groups of North

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American infants over the past century) and to reveal (through alignment and intercomparison of materials not previously placed in juxtaposition) new items of knowledge inherent in the existing data. Among the problems given consideration are those of age, sex, lineage, socio-economic level, birth order, prematurity, diet, and disease. Insofar as the problems necessitate and the data are adequate, emphasis is placed both on average values and on variation within groups. Coincident with the central task of epitomizing and extending a specified sector of knowledge, reference is made to problems awaiting exploration or needing additional study.

Three further notations are pertinent. In describing each investigation attention is given to the size and leading characteristics of the sample, to the anthropometric technique employed, to the procedures followed in grouping the data for analysis, and to the statistical media used in deriving and presenting the results. As far as possible head girth values are reproduced at monthly ages between birth and three months, at quarterly ages between three months and one year, and at semiannual ages between one and two years; in a few instances (2, 4, 12) values at ages near these are accepted for review purposes and then, before being used comparatively, are corrected by graphic interpolation to represent the ages chosen. It may be assumed as beyond reasonable doubt that whenever an "average" is reported either the arithmetic mean or the median was computed; opportunely, it has been found (21, 28, 34) that there is no systematic difference at the infancy ages between mean head girth and median head girth.

Presentation of Source Materials

In 1883 Ramsay (24) published records for "cranial circumference" on a small group of "southern Negro" males two years of age. The sample was obtained in Georgia and consisted of four subjects. Description of the anthropometric technique was not carried beyond the statement that the measurements were "carefully taken with a neat graduated tape, in the presence of reputable persons" (24, p. 397).

HEAD GIRTH (cm.) OF NEGRO MALES MEASURED IN GEORGIA

Age	Number	Mean	Minimum	Maximum
24 mos.	4	48.7	47.0	50.5

Commenting on the data, Ramsay stated: ". . . they are the only effort I have seen in this direction" (24, p. 397).

Data for head circumference on 98 New York infants, probably White, were reported by Chapin (9) in 1894. The subjects ranged in age between birth and two years. They were ". . . all hospital cases, taken either from the Infant Asylum or the babies' wards, and many were thus much below par" (9, p. 650). No discussion was given of their racial stocks beyond reference to one subject as Polish. Head girth was obtained "by passing the tape horizontally around the head, passing over the glabella and a point just above the external occipital protuberance" (9, p. 649). The subjects were "carefully measured."

HEAD GIRTH (cm.) OF HOSPITALIZED INFANTS, PROBABLY WHITE

Age Group Midpoint	Range	Number	Mean
3 days	0 thru 6	9	34.7
18 days	7 thru 30	20	35.1
3 mos.	1 thru 4	27	37.7
6 mos.	5 thru 8	9	38.9
9 mos.	7 thru 10	13	42.1
12 mos.	11 thru 12	6	44.9
15 mos.	13 thru 17	8	46.8
21 mos.	18 thru 23	6	47.4

Twenty-seven of the 29 infants under one month of age were breastfed. Of the 27 between the ages of one and five months, 10 were "on breast."

Holt (14), in 1897, published averages for head circumference ("occipito-frontal measurement") at birth and at successive semiannual ages to two years. The birth values were determined from records on "four hundred and forty-six full-term infants taken in about equal numbers from the Sloane Maternity Hospital and the New York Infant Asylum" (14, p. 22). The number of observations employed at older ages was not indicated; probably these data were collected in private practice. No specific discussion was given of the socio-economic or ethnic characteristics of the total sample or of the newborn series.

HEAD GIRTH (cm.) OF PHYSICALLY NORMAL NEW YORK INFANTS

Age (mos.)	Males		Females		Male Average minus Female Average
	Number	Average	Number	Average	
Birth	251	35.5	215	34.5	1.0
6	...	45.5	...	42.2	1.3
12	...	45.9	...	44.6	1.3
18	...	47.1	...	45.9	1.2
24	...	48.2	...	47.2	1.0

For each sex, average head girth at two years was found to exceed that at birth by 12.7 cm. Growth in head girth was "most rapid during the first year, the increase being about four inches (10.0 cm.). During the second year the increase was about one inch" (14, p. 22).

In the 1903 edition of his textbook, Obstetrics, Williams wrote: "The greatest circumference of the head, which corresponds to the plane of the fronto-occipital diameter, is 34.5 centimeters" (36, p. 136). This average value was stated to have been derived from "measurements of a large number of heads just after birth" (36, p. 136). The data were probably obtained in Maryland on White infants. Williams called attention to "individual variations" above and below the average and made the following additional notation: "As a rule, boys have somewhat larger heads than girls, and the children of multiparae than those of primiparae" (36, p. 136).

Data for occipito-frontal circumference were analyzed by Fleischner (11), in 1906, on 500 infants "divided rather arbitrarily into well nourished, fairly well nourished, and poorly nourished classes" (11, p. 740). The subjects were "all under a year old" and "all hospital patients" at the New York Foundling Hospital, the Nursery and Child's Hospital, or the Sea-Side Hospital of St. John's Guild, New York City. Roughly 25 per cent were classified as well nourished, 35 per cent as fairly well nourished, and 40 per cent as poorly nourished. No indication was given of the number of infants at each age.

HEAD GIRTH (cm.) OF NEW YORK INFANTS OF THREE "NUTRITIONAL" GROUPS

Age (mos.)	Well Nourished	Fairly Well Nourished	Poorly Nourished
	Average Head Girth		
0.5	37.5	35.6	35.5
3.0	40.1	38.6	38.2
6.0	42.6	40.8	39.2
9.0	44.4	42.9	41.2
11.5	45.7	44.1	42.7
	Increase in Average Head Girth		
.5 to 6.0	5.1	5.2	3.7
6.0 to 11.5	3.1	3.3	3.5
.5 to 11.5	8.2	8.5	9.2

The "well nourished" infants yielded an average head girth for the first month higher than that from the "poorly nourished" infants at three months. Similarly, the average for "poorly nourished" infants of the twelfth month was almost identical with that from the "well nourished" at six months. Age differences in the averages afforded increases "less in the well nourished than in the poorly nourished" (11, p. 747).

Whether viewed from the standpoint of making comparisons with other studies, or of drawing conclusions from differences between the three subgroups, Fleischner's study is seriously lacking in specificity. This follows since it is not known what range of conditions "hospital patients" encompassed, or to what extent the size of a child entered into his classification as well, fairly well, or poorly nourished. In the latter connection, mention was made of the "probability" that a "large majority" of the poorly nourished group was "premature" (11, p. 743).

Averages for head circumference at semiannual age intervals from birth to two years were reported by Macy (19) in 1912. The basic data were gathered from "examinations of 800 children" (19, p. 629). Neither the measurement technique nor the subjects were described. The latter were probably residents of New York City.

AVERAGES FOR HEAD CIRCUMFERENCE (cm.) AT SEMIANNUAL AGES

Birth	6 mos.	12 mos.	18 mos.	24 mos.
38.6	44.2	45.0	48.0	49.0

Macy considered these values "indicative of the general tendencies of growth" for head girth in infancy.

In 1914 Montague and Hollingworth (23) analyzed measurements of "occipito-frontal" girth "made immediately after birth." The data were obtained from "obstetrical histories of the New York Infirmary for Women and Children . . . a hospital situated on the lower East Side of New York City" (23, pp. 345-346). They were probably accumulated during the years 1910 to 1914. Records were rejected if marked "premature," "syphilitic," or "twin." The investigators "began in the files with the last infant born and proceeded to transcribe from the records the measurements of 1,000 consecutive males and 1,000 consecutive females" (23, p. 346). Socio-economically the subjects were "very homogeneous . . . there being very few from the economically well-to-do classes" (23, p. 346). Ethnically they were "extremely heterogeneous . . . with Hebrews, Italians, and Slavs predominating . . . [and] few Negroes, Turks, or Asiatics included" (23, p. 346). The measurements were taken "with a metal tape."

HEAD GIRTH (cm.) OF NEW YORK (LOWER EAST SIDE) INFANTS AT BIRTH

Sex	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
Males	1000	34.2	1.67	4.9	33.1	35.2	29.0 - 41.5
Females	1000	33.6	1.55	4.8	32.6	34.7	28.0 - 39.5

With respect to central tendency, male infants were larger than female infants. Males showed slightly greater absolute and relative variability. Fifty per cent of the head girth observations for each sex fell within a zone of 2.1 cm.

Grover (13), in 1915, published means based upon 123 records of head circumference for physically normal infants ranging in age from five days following birth through twenty-six months. Head girth was measured as "the greatest circumference obtainable" (13, p. 475). "Only children with a normal appearance were measured" (13, p. 474). The sample was drawn in Boston: "Most of the children were among the out-patients of the Children's Hospital . . . Some were bed patients in the wards. Others were measured at the milk stations of the Milk and Baby Hygiene Association, . . . at the Boston Lying-In Hospital," or as "private patients" (13, p. 473).

HEAD GIRTH (cm.) OF BOSTON INFANTS

Age Group Midpoint (mos.)	Age Group Range	Males N	Males Mean	Females N	Females Mean	Both Sexes N	Both Sexes Mean
1	0 thru 1	4	36.7	3	35.8	7	36.2
3	2 thru 5	7	38.6	9	37.7	16	38.1
6	4 thru 7	14	42.5	11	41.5	25	42.1
12	9 thru 14	11	44.8	12	44.9	23	44.8
18	15 thru 20	14	46.9	7	45.8	21	46.5
24	21 thru 26	14	48.2	9	48.3	23	48.3

Differences between means were found to be greater for the age period from three to six months than for that from one to two years.

Means for head circumference derived from measurement of 7,126 infants aged six months to two years were reported in 1916 by Crum (10). The data were collected in thirty-one states at Better Babies Contests sponsored by the Woman's Home Companion and Baby Health Conferences fostered by the American Medical Association. They were amassed between 1913 and 1916 "according to uniform rules," "The great majority of the children . . . were of American-born parents . . . of different stocks, including German, Irish, Swedish, some Italian, and some of various other races" (10, p. 336). Means were given at monthly intervals.

HEAD GIRTH (cm.) OF "BABY CONTEST" AND "HEALTH CONFERENCE" INFANTS

Age (mos.)	Males N	Males Mean	Females N	Females Mean	Male Mean minus Female Mean
6	259	44.1	176	42.9	1.2
9	211	45.8	103	44.7	1.1
12	284	47.1	228	45.9	1.2
15	216	47.8	197	46.6	1.2
18	181	48.4	178	47.1	1.3
21	159	48.9	142	47.6	1.3
24	201	49.3	160	48.2	1.1

These mean values were considered standards for normal, healthy American infants. On the one hand, the racial composition of the sample would tend to make it more representative than if infants of northwest European ancestry only had been included. On the other hand, infants brought to health conferences and "baby shows" (at many of which prizes were given) would probably be predominantly well developed.

The averages presented in Holt's 1897 edition of The Diseases of Infancy and Childhood (14) were revised by Holt and Howland (15) in 1919. At birth, the 1897 figures were duplicated in a tabulation given on page 22, but revised in a table afforded on page 19. Beyond birth, the revision sample, in common with the original, was not described as to size or selection. The data were probably accumulated in private pediatric practice, and possibly collected partly in New York and partly in Baltimore.

AVERAGE HEAD GIRTH (cm.) OF "HEALTHY" MALE AND FEMALE INFANTS

Age (mos.)	Males		Females	
	Initial (1897)	Revision of 1919	Initial (1897)	Revision of 1919
Birth	35.5	35.5	34.5	34.5
6	43.6	43.2	42.2	42.5
12	45.9	45.7	44.6	44.5
18	47.1	47.5	45.9	45.7
24	48.2	48.7	47.2	47.5

Compared with the averages published in 1897, the averages for each sex in the 1919 table were slightly lower at birth and higher at two years. Specific for males, the 1919 figures were lower at birth, six months and one year, higher at eighteen months and two years. For females, the earlier figures were higher at birth, one year and eighteen months, and the later figures at six months and two years. All differences were small.

In the eighth (1923), ninth (1926), and tenth (1933) editions of The Diseases of Infancy and Childhood the only change made was that for average head circumference of male infants at birth; this was given as 35.2 cm. The ninth edition carried the statement that the authors had utilized "about two thousand personal observations upon children from one to five years old, chiefly from private practice" (15, p. 19). It appears a reasonable inference that the number of head girth measurements at ages one year, eighteen months and two years approximated 100 for each sex.

In 1919 Taylor (32) reported a statistical reduction of measurements for head girth on 250 neonates, 125 of each sex, born 1914-17. The measurements were made at the University Hospital, Minneapolis - a charity hospital admitting primiparous women almost exclusively. All of the subjects were "normal and born at term" (32, p. 353). The mothers were approximately 40 per cent of Scandinavian descent, 40 per cent of other northwest European ancestry, and the remainder of Jewish or central European stocks. "The occipitofrontal circumference" was determined "with a steel millimeter tape" (32, pp. 353, 355). "Eighty-one per cent of the babies were measured on the fourth, fifth, or sixth day of life, none earlier than the second, and none later than the tenth" (32, p. 353).

HEAD GIRTH (cm.) OF MINNEAPOLIS NEONATES, PREDOMINANTLY FIRST-BORN

Sex	Median Age	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
Males	5 days	125	34.7	1.15	3.2	34.2	35.5	30.8 - 37.8
Females	5 days	125	34.1	1.25	3.6	33.4	34.8	30.0 - 36.6

In contrast with the earlier findings of Montague and Hollingworth (23), the females showed slightly greater variability than the males. Supplementary study was made of the relationship between head girth and stature. The coefficients obtained (Pearson product-moment method of correlation) were .77 for males and .79 for females.

Measurements of circumference for a small series of infant heads largely free from "birth moulding" were analyzed in 1922 by Calkins (8). The subjects were 27 full-term, living infants born by "cesarean section" or "breech extraction." They varied in stature between 48.0 cm. and 53.5 cm. - all were "born within two weeks of term, according to the menstrual history" (8, p. 126). Head girth was measured as the maximum perimeter "taken around glabella and inion" (8, p. 115). The determinations were made on the day of birth. "A very slight uniform pressure was used in all the measurements with the idea of entirely avoiding compression" (8, p. 116).

GIRTH (cm.) OF "UNMOULDED" INFANT HEADS AT BIRTH

Sex	N	Mean	Minimum	Maximum
Males	18	35.2	33.0	37.5
Females	9	35.1	33.4	36.5
Both	27	35.2	33.0	36.5

Attention is called to Calkins' description of the tension applied when determining head circumference. The majority of investigators have failed to discuss this aspect of their anthropometric technique; among the 20 per cent not chargeable with this omission, practice has ranged from "avoiding any compression" (8, 33) to drawing the tape tightly (5, 17, 21).

Talbot (30), in 1924, presented data for head girth collected on approximately 200 "clinically normal American children" between the postnatal ages of two weeks and two years. The subjects were claimed "not to represent exceptionally well nourished or poorly nourished children" and characterized as "average children within the accepted normal limits of height and weight for age" (30, p. 541). Roughly half were males and half females. They were apparently in residence at the "Directory for Wet-Nurses of the Boston Infants' Hospital" during 1915-17. "Conditions here were especially favorable for the collection of normal data, as the children, mostly breast-fed, were the offspring of resident normal wet-nurses" (30, p. 25). Head girth was measured "from occiput around the frontal bosses" (30, p. 543).

For each sex separately, the records on every individual for age (abscissa value) and head circumference (ordinate value) were "plotted on charts, and a smoothed curve drawn to indicate the trend of growth" (30, p. 541). Two points should be noted with the reference to these curves; they "do not represent mathematical averages" and, as published, they are difficult to read. The tabulation which follows gives five points through which the trend for each sex (as shown on pp. 543-544) is estimated to pass.

HEAD GIRTH (cm.) OF "NORMAL, HEALTHY" BOSTON INFANTS

Age (mos.)	Males		Females	
	Number of Subjects	Estimated Average	Number of Subjects	Estimated Average
6	20	39.4	15	39.4
6	25	42.6	25	42.3
12	15	46.8	25	46.0
18	15	40.5	15	47.6
24	10	49.2	10	48.8

That these figures must be regarded as no more than crude estimates of central tendency is attested by the fact that short trend lines intended as reproductions of a segment of each curve (31, p. 522) yield values for head girth at age three months of 44.8 cm. for males and 40.3 cm. for females.

A second study reported by Talbot (31) in 1924 dealt with the head circumference of infants "organically sound" but "from four to ten weeks premature" (31, p. 30). "The criteria used in establishing prematurity were weight, stature, and general considerations, such as facies, texture of the skin, undeveloped nails, cry, unstable temperature and history of expected birth" (31, p. 30). Head circumference was measured on 10 males and 10 females at varying postnatal ages between seven and forty-five days. The subjects were born 1920-22 and housed partly at the Boston Lying-In Hospital and partly at the Children's Department of the Massachusetts General Hospital. Three were measured at two ages.

HEAD GIRTH OF PREMATURE INFANTS AT POSTNATAL AGES 7 TO 45 DAYS

Age Group Mean (days)	Range	N	Head Girth Mean (cm.)	Range	Stature Mean (cm.)	Range	Weight Mean (gm.)	Range
12	7-18	10	29.2	25.2-31.0	43.1	30.0-46.5	1660	1304-2098
30	21-45	18	30.8	28.0-32.4	45.1	36.0-47.7	1857	1191-2559

These means were found to be markedly lower than any of the available means for full-term infants of like postnatal ages.

Utilizing 394 different infants, Richdorf (26) accumulated nearly six hundred measurements of head circumference distributed almost equally in each of the first twelve postnatal months. The data, obtained with a steel millimeter tape, represented "the largest horizontal circumference passing about the frontal eminences and occipital portion of the head" (26, p. 26). They were subjected to statistical analysis in 1925. The subjects were characterized as (a) residents of Minneapolis, St. Paul, and Rochester, Minnesota, (b) "all Caucasian," with "the majority of Northern European extraction," and (c) all negative for congenital abnormality, prematurity, birth injury, acute and chronic disease, and "nutritional disorder." Their fathers were "skilled workmen, tradesmen, or professional men" (26, p. 14). With respect to diet and health care: "Medical attention and instruction in child care was available for the mothers . . . All mothers were urged to breast feed their babies. Solid food (cereal well cooked) was begun from the fourth to the seventh month, and vegetables about a month later . . . Orange juice was given in all cases . . . Cod liver oil and sunlight were recommended almost routinely" (26, pp. 15-16).

HEAD GIRTH (cm.) OF MINNESOTA URBAN INFANTS OF MIDDLE AND UPPER CLASSES

Age Group Midpoint	Range	N	Mean	S.D.	V	Percentiles 25th	75th	Range
				Males				
7 days	5 thru 9	20	35.0	1.06	3.2	34.0	36.0	32.8 - 37.5
6 wks.	4 thru 7	25	39.2	1.26	3.1	37.5	39.1	35.5 - 41.5
3 mos.	2 thru 3	50	40.6	1.53	3.8	39.4	41.6	37.0 - 44.0
6 mos.	5 thru 6	50	43.5	0.98	2.2	42.9	44.2	41.5 - 45.9
9 mos.	8 thru 9	49	45.4	1.20	2.6	44.6	46.2	43.0 - 49.0
11 mos.	10 thru 11	50	46.6	1.40	3.0	45.5	47.5	44.5 - 49.5
				Females				
7 days	5 thru 9	21	34.4	0.95	2.8	34.0	35.0	32.5 - 35.5
6 wks.	4 thru 7	25	37.5	0.89	2.2	36.7	38.2	36.2 - 38.7
3 mos.	2 thru 3	50	39.1	1.11	2.8	38.4	39.8	37.0 - 41.3
6 mos.	5 thru 6	50	42.3	1.35	3.2	41.5	42.9	39.2 - 44.8
9 mos.	8 thru 9	49	44.7	1.40	3.1	43.8	45.5	42.1 - 48.5
11 mos.	10 thru 11	48	45.6	1.31	2.9	44.7	46.2	43.2 - 48.8

For the fifty subjects of each sex in the "6 mos." age group, supplementary study was made of head circumference in relation to head length and head breadth. On males, Pearson product-moment coefficients of correlation were .76 for circumference with length and .44 for circumference with breadth. Practically identical findings were obtained on females (r = .79 for circumference with length, r = .44 for circumference with breadth).

Means for head girth at three infancy ages - one week following birth, six months, and eighteen months - were obtained in 1926 by Swanson (29). The subjects were 90 White, "healthy normal" females examined 1924-25 in Minneapolis and St. Paul, Minnesota. They were obtained through hospitals, orphanages and homes. In compiling the neonate series, "prematurity [birth weight less than 2500 gms.], birth injury and congenital abnormalities were considered definite causes for rejection" (29, p. 13). At older ages, any gross pathology - deformity, malfunction, disease condition - was cause for rejection. The parents were about 70 per cent of British, Scandinavian or German descent and 30 per cent of central or south European ancestry. They varied "from the pauper to the upper class," the majority being "middle class" (29, p. 17). Measurement was made of "the largest horizontal circumference passing through the frontal eminences and the occipital protuberance" (29, p. 24); the tape was brought "snugly in contact with the skin all around" (29, p. 21). One anthropometrist, Swanson himself, took the entire series of records.

HEAD GIRTH (cm.) OF "TWIN CITIES" FEMALE INFANTS FROM MIDDLE CLASSES

Age Group Mean	Range	Number	Mean
7 days	0 thru 14	30	33.9
6 mos.	0.5 thru 11	30	40.8
18 mos.	12 thru 23	30	46.0

The difference between the means for ages one week and six months was greater than that between the means for ages six and eighteen months, i.e., the increase over the first six months of postnatal life exceeded that during the succeeding year.

In 1930, Baldwin, Fillmore and Hadley (4) reported an analysis of head circumference data for 232 infants between the ages of birth and thirty months living in a rural area. The data were collected during the years 1923-26 on infants residing in rural communities of east-central Iowa. Head circumference was taken with a steel millimeter tape as the maximum girth "over the frontal and occipital processes." Careful attention was given to the maintenance of vigorous standards of anthropometric procedure; the anthropometrists were "Mrs. Gladys Davis, Mrs. Laura Busby, Miss Edna Armstrong, Miss Dorothy Bradbury, and Mr. Elmer Olander."

HEAD GIRTH (cm.) OF IOWA RURAL INFANTS EXAMINED 1923-26

Age Group Midpoint (mos.)	Range	Males N	Mean	S.D.	V	Females N	Mean	S.D.	V
3	0 thru 5	16	41.4	2.3	5.6	12	39.4	2.1	5.3
9	6 thru 11	31	45.0	1.6	3.5	26	44.2	1.9	4.3
15	12 thru 17	36	47.6	1.3	2.7	20	46.2	2.4	5.2
21	18 thru 23	28	48.1	1.4	2.9	22	47.4	1.2	2.5
27	24 thru 29	25	49.7	1.3	2.6	18	48.3	1.0	2.1

Central tendency values at semiannual ages from six months to two years were derived by the reviewer, using the medium of graphic interpolation:

Age:	6 mos.		12 mos.		18 mos.		24 mos.	
Sex:	Males	Females	Males	Females	Males	Females	Males	Females
Head girth:	44.1	42.2	46.9	45.4	48.4	46.8	49.4	47.9

Also in 1930, Tiber (33) analyzed series of measurements of head girth taken within six hours after birth and at the end of the first postnatal week. The subjects were 208 "mature, healthy, Caucasian" neonates "delivered at the obstetrical department of the Ancker Hospital of St. Paul, Minnesota, in the winter of 1928-29" (33, p. 32). In selecting the subjects there were five criteria of exclusion: prematurity, physical abnormality, non-Caucasian ancestry, illness, and failure to survive the first week of postnatal life. From information on maternal age, ancestry and parity, it was found that one-third of the mothers were primiparae, two-thirds between eighteen and twenty-eight years of age, and four-fifths of northwest European stocks. Head girth was taken with a linen millimeter tape as "the greatest circumference passing through the glabella" (33, p. 35). Readings were made using "slight uniform pressure . . . for the purpose of removing any slack in the measuring tape and at the same time avoiding any compression of the part" (33, p. 38).

HEAD GIRTH (cm.) OF NEONATES BORN AT ST. PAUL 1928-29

Age	Males				Females			
	N	Median	Percentiles 25th	75th	N	Median	Percentiles 25th	75th
Birth	106	33.8	32.7	34.8	102	33.1	32.3	34.0
7 days	106	34.4	33.4	35.3	102	33.6	32.8	34.5

The median for males at birth was higher than that for females one week after birth. At both ages the central one-half of the records were encompassed within zones of 1.7 cm. for females and approximately 2.0 cm. for males.

The Iowa Child Welfare Research Station (16), in 1931, published a statistical study of records for head circumference distributed over the age period from two weeks to twenty-four and one-half months. The subjects were "Iowa infants," probably residents of east-central Iowa. Apparently they were obtained during the early 1920's at one-day clinics "held in various towns and cities in the state" and following 1925 through a permanent clinic at Iowa City. In determining the head girth a steel millimeter tape was passed "over the most prominent point on the occipital protuberance and . . . over the greatest prominences in the temporal and frontal regions" (16, p. 1142). Each record was based on determinations by two anthropometrists.

HEAD GIRTH (cm.) OF IOWA INFANTS

Age Group Midpoint (mos.)	Range	Males N	Mean	S.D.	V	Females N	Mean	S.D.	V
1	0.5 - 1.5	14	37.5			13	35.1		
2	1.5 - 2.5	22	39.3	1.39	3.5	8	37.6		
3	2.5 - 3.5	26	40.6	1.37	3.4	8	39.3		
6	5.5 - 6.5	40	44.3	1.63	3.7	19	42.7	1.62	3.8
9	8.5 - 9.5	32	45.2	1.27	2.8	24	44.5	1.48	3.3
12	11.5 - 12.5	26	47.1	1.49	3.2	25	45.5	1.18	2.6
15	14.5 - 15.5	17	47.5	1.23	2.6	14	46.9		
18	17.5 - 18.5	23	48.0	1.25	2.8	13	47.4		
24	23.5 - 24.5	17	50.0	1.13	2.3	23	48.2	1.32	2.7

The absence of variability values at certain ages follows, of course, from the fact that with samples of less than fifteen items such values were considered too unstable to merit calculation.

Head girth data on 100 full-term neonates were presented by Stebbins (27) in 1933. The subjects were born at the University Hospitals, Iowa City, during February and March, 1933; in every instance weight at birth exceeded 2500 gm. Their parents were described as "White, American," below average in socio-economic status. With the aid of a "standardized linen tape," head circumference was "taken with the tape over the greatest prominences of the frontal and occipital bones. An assistant held the tape in place at the back of the head" (27, p. 7). Each subject was measured on the second day (24 to 48 hours after birth) and again on the ninth day.

HEAD GIRTH (cm.) OF IOWA NEONATES OF LOWER CLASSES

Age (days)	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
2	50	34.6	1.00	2.9	32.6	33.3	34.0	34.6	35.1	35.9	37.3
9	50	35.0	1.02	2.9	33.1	33.5	34.4	35.0	35.5	36.4	37.4
					Females						
2	50	33.6	0.96	2.8	31.4	32.4	32.9	33.6	34.4	34.9	35.2
9	50	34.0	0.97	2.9	31.8	32.8	33.2	33.9	34.7	35.2	35.6

Comparable means were found to be one centimeter higher for males than for females. The mean for females at nine days was identical with the twenty-fifth percentile for males at two days. At both ages, 50 per cent of the male records fell within a zone of 1.1 cm. and 50 per cent of the female records within a zone of 1.5 cm. The range was greater for males than for females by 1.2 cm. at two days and 1.1 cm. at nine days.

In 1934 Bakwin and Bakwin (1) studied head circumference in relation to sex and order of birth utilizing a sample of "1653 new-borns." The subjects were White infants born at four New York City hospitals (Bellevue Hospital, Fifth Avenue Hospital, New York Nursery and Children's Hospital, and New York Infirmary for Women and Children) between about 1929 and 1934. Approximately 55 per cent were obtained through the Bellevue Hospital and 25 per cent through the Fifth Avenue Hospital. Infants born at the former were "almost exclusively from very poor homes," those born at the latter, "for the most part, from homes of moderate income" (1, p. 616). Head girth was taken as "the largest circumference of the head" (1, p. 371). "All measurements were made by Miss Allene Jones" (1, p. 612).

With reference to change in mean head girth during the early days of postnatal life, Bakwin and Bakwin stated: "The head measurements in this series of infants during the first 3 days of life showed no differences from means for the first 7 days of life and therefore all measurements are included in the calculations" (1, p. 612).

HEAD GIRTH (cm.) OF NEWBORN INFANTS "BY SEX AND ORDER OF BIRTH"

Sex	First-born Infants N	Mean	S.D.	V	Later-born Infants N	Mean	S.D.	V
Males	395	34.5	1.21	3.5	423	34.8	1.36	3.9
Females	417	33.9	1.34	4.0	418	34.1	1.17	3.4

Mean head girth was found to be "larger in males than in females and in later born than in first born infants" (1, p. 612). Disregarding birth order, means were obtained of 34.6 cm. for the 818 males and 34.0 cm. for the 835 females.

A comparative study of head circumference on premature and full-term infants was made by Mohr and Bartelme (22) in 1934. The data consisted of 158 head girth records on premature infants (birth weight less than 2500 gm.) and 30 comparable records on full-term infants. They were accumulated in Chicago during the period 1929-33. The subjects were White, native-born infants, about 30 per cent Jewish and 60 per cent of northwest European ancestry. Occupation of father, home ratings, and incidence of free hospital care showed them to "represent a slightly inferior socio-economic group" (22, p. 65). The premature infants were the recipients of "excellent" postnatal care and follow-up afforded by the Premature Infant Station, Sarah Morris Hospital of Michael Reese Hospital. The full-term infants were siblings of the premature infants.

In analysis, statutory age was used on the full-term subjects and, on those prematurely born, statutory age minus the estimated amount of prematurity. Separate analyses were made for full-term infants, for premature infants weighing 1000-1500 gm. at birth, for premature infants weighing 2000-2500 gm. at birth, and for the total sample of premature infants. The mean gestation period for the total premature group was approximately thirty-four weeks. Consequently, for this group, the ages given in the following tabulation are about six weeks less than average statutory age.

HEAD GIRTH (cm.) OF CHICAGO PREMATURE AND FULL-TERM INFANTS

Age (mos.)	Premature Infants: Birthweight 1000-1500 gm. N	Premature Infants: Birthweight 1000-1500 gm. Mean	Premature Infants: Birthweight 2000-2500 gm. N	Premature Infants: Birthweight 2000-2500 gm. Mean	Total Premature Sample N	Total Premature Sample Mean	Total Premature Sample S.D.	Total Premature Sample V	Full-term Infants N	Full-term Infants Mean
				Males						
3	2	36.0	1	36.0	3	36.6				
6	2	39.3	1	48.3	5	41.7			5	42.0
9	3	45.3	1	40.8	6	44.0			1	47.5
12			1	44.8	3	45.6			1	46.3
18	6	47.7	6	48.3	20	48.2	1.45	3.0	4	48.3
24	5	46.7	11	47.3	30	47.6	1.41	3.0	3	50.5
				Females						
3	1	42.3	1	37.8	3	38.1				
6	2	41.5	2	41.3	5	42.4			2	44.8
9	3	44.9			9	44.4			4	44.3
12	2	48.3	4	44.8	13	46.0	2.99	6.5		
18	6	48.3	6	47.8	28	47.2	2.62	5.6	8	46.2
24	5	48.4	10	48.4	33	47.8	1.75	3.7	2	48.3

The paucity of data at ages below eighteen months was acknowledged. At no age was the number of full-term infants adequate. Had the size of the samples been satisfactory, caution would still be necessary in any attempt to utilize the figures obtained in formulating an inference regarding the comparative rate of growth in head girth of full-term infants and infants born prematurely. This follows since for the premature infants age was corrected for the degree of prematurity and exceptional environmental provisions were made to facilitate growth. The investigators made the following summary statements: Premature infants "do not differ from the siblings in head circumference" (22, p. 96); "mean head circumferences for children who weighed 1,500 grams or less at birth remain consistently below the mean measurements for those weighing 2,000 grams or more at birth" (22, p. 103); and "measurements of head circumferences do not indicate persistence of large head circumferences as a result of megacephalus observed among the prematurely born children . . . some of the megacephalic children actually fall below the mean values for this measurement" (22, p. 103).

Stuart (28), in 1934, reported a statistical reduction of head girth data obtained on 119 White infants each measured one to eight times at ages between birth and two years. Collection of the data was prosecuted during the years 1930-34 by the anthropometric staff of the Center for Research in Child Health and Development, Harvard University. The subjects were born at the Boston Lying-In Hospital. All were "of American or North European parentage" and roughly half of Irish descent. None weighed less than "5 pounds at birth," none were "sick or clinically abnormal" (28, p. 199). Occupational classification of the fathers showed approximately 30 per cent to be unskilled or semiskilled, 50 per cent skilled, and 20 per cent of the managerial or professional classes. The examinations of the subjects included a comprehensive medical evaluation and afforded parents both general and individualized "advice as to feeding and care" (28, p. 31). With few exceptions, the "accepted immunizations" were "carried out at the appropriate ages" (28, p. 28).

Head circumference was taken "through the supraorbital ridges anteriorly and greatest occipital prominence posteriorly" (28, p. 200). At each examination measurements were secured by two anthropometrists, usually Vernette Vickers and Constance Shaw. Examinations were made within 48 hours following birth, within two days of two postnatal weeks, and within one week of ages, 3, 6, 9, 12, 18, and 24 months.

HEAD GIRTH (cm.) OF BOSTON MIDDLE CLASS, CLINIC SUPERVISED INFANTS

Age	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
Birth	50	35.4	1.3	3.7	32.4	33.7	34.5	35.4	36.0	37.3	38.0
2 wks.	35	36.3	1.2	3.3	33.9	35.0	35.5	36.3	37.0	37.9	38.2
3 mos.	50	41.0	1.3	3.2	38.6	39.2	40.1	41.0	41.8	42.7	44.0
6 mos.	45	44.9	1.1	2.4	41.8	42.5	43.3	44.2	45.0	45.7	46.0
9 mos.	41	46.0	1.1	2.4	43.6	44.4	45.1	46.1	46.7	47.4	48.4
12 mos.	37	47.2	1.0	2.1	45.1	45.6	46.5	47.3	47.9	48.6	49.3
18 mos.	34	49.1	1.2	2.4	47.0	47.4	48.1	48.9	49.8	50.9	51.2
24 mos.	26	50.0	1.3	2.6	47.8	48.2	49.1	50.1	50.9	51.7	52.0
					Females						
Birth	65	34.4	1.4	4.1	31.2	33.1	33.7	34.7	35.5	36.0	37.0
2 wks.	50	35.5	1.2	3.4	32.8	33.7	34.8	35.6	36.5	37.2	39.0
3 mos.	69	40.2	1.2	3.0	38.2	38.5	39.1	40.2	41.1	41.8	42.6
6 mos.	57	43.1	1.3	3.0	41.0	41.4	42.1	43.0	43.9	44.8	45.2
9 mos.	54	44.8	1.4	3.1	42.3	42.9	43.8	44.7	45.8	46.8	47.9
12 mos.	48	46.0	1.4	3.0	43.6	44.1	44.9	45.9	46.9	47.8	49.1
18 mos.	44	47.4	1.4	3.0	44.8	45.7	46.4	47.3	48.3	49.5	50.1
24 mos.	30	48.2	1.3	2.7	46.2	46.5	47.2	48.0	49.2	50.0	50.5

The mean given at age six months for males is seemingly a spurious value. It appears probable that the mean obtained was either 43.9 cm. or 44.3 cm.

In an investigation published in 1936, Bayley and Davis (5) presented an analysis of data for head girth accumulated on 60 infants of Berkeley, California. The subjects - normal infants born at two Berkeley hospitals 1928-29 and remaining reasonably healthy and well nourished throughout infancy - were measured repeatedly, many of them at sixteen different ages between birth and two years. Their parents were White, "English-speaking" people, predominantly of northwest European or early American stocks. They were interested in bringing their infants for periodic examination to the Institute of Child Welfare, University of California. The mean educational level of the fathers was 13.8 years; of the mothers, 13.1 years. The mean annual income was $2844, thirty per cent of the fathers being engaged in "professional or executive occupations." Examinations were made at "birth," at ("or within a few days of") each month of age from one to twelve, and at ages fifteen, eighteen and twenty-four months.

The technique employed in obtaining the birth measurements was not discussed. At older ages, head circumference was measured "with a linen tape graduated in millimeters, and having a spring attachment at one end by which the pressure could be kept constant" (5, p. 30). The tape was passed over the most posterior point in the occipital region and "over the greatest prominences in the temporal and frontal regions." Most of the measurements were taken by Bayley, a "few" by Dr. L. V. Wolff. "Every effort was made to overcome unreliability" (5, p. 31).

Indirect estimates of the reliability of the data were made using two approaches. First, ". . . fifteen infants in a San Francisco baby home, ranging in age from nine days to seven months, were measured, and then remeasured by Bayley after an interval of one week" (5, p. 34). It was found that the means and standard deviations from these two series of records were practically identical. Secondly, coefficients of correlation were obtained by successively pairing the measurements from one regular examination of the subjects with those taken at the next regular examination. The mean of these coefficients ($r = .92$) was considered to imply a "high degree of precision" (5, p. 33).

HEAD GIRTH (cm.) OF BERKELEY INFANTS EXAMINED 1928-31

Both Sexes

Age (mos.)	N	Mean	S.D.	V	Percentiles 25th	75th
Birth	53	35.0	1.88	5.4		
1	50	37.8	1.35	3.6	36.9	39.5
2	59	39.5	1.32	3.3	38.5	40.2
3	60	40.9	1.35	3.3	40.0	41.5
6	58	44.1	1.32	3.0	43.1	45.0
9	58	46.2	1.58	3.4	45.1	47.1
12	55	47.6	1.60	3.4	46.7	48.6
15	52	46.4	1.53	3.2	47.2	49.2
18	45	48.9	1.58	3.2	47.7	49.8
24	42	50.0	1.59	3.2	48.7	50.9

	Males				Females			
	N	Mean	S.D.	V	N	Mean	S.D.	V
Birth	28	35.5	1.15	3.2	25	34.5	1.38	4.0
1	24	38.6	1.19	3.1	26	37.1	1.22	3.3
2	31	40.1	1.13	2.8	27	38.8	1.19	3.1
3	31	41.5	1.20	2.9	29	40.2	1.06	2.6
6	30	44.9	1.17	2.6	28	43.3	1.18	2.7
9	27	47.0	1.15	2.5	29	45.4	1.29	2.9
12	28	48.5	1.30	2.7	27	46.0	1.36	2.9
15	27	49.3	1.38	2.8	25	47.5	1.10	2.3
18	22	49.8	1.30	2.6	23	48.0	1.28	2.7
24	24	50.7	1.43	2.8	18	49.0	1.15	2.4

At birth, the minimum and maximum records were reported. These were 33.3 cm. and 39.0 cm. for the male sample, 31.3 cm. and 37.0 cm. for the female sample.

Blatt and Schapiro (8) in 1935 studied "whether the circumference of the head has any relation" to inclusion of a special cereal mixture in the dietary of infants. The subjects were 136 "well" infants, ranging in age from three to twenty-three months. They were housed at St. Vincent's Infant and Maternity Hospital, Chicago, during the years 1931-33 and "observed for periods varying from six weeks to one year" (8, p. 325). "Cow's mild with dextrimaltose formed the basis of the infants' diets. A regimen of orange juice and cod liver oil was begun during the first month. Cereal became a dietary component when the infant was 3 months old. Vegetables and soups were given at 6 months. Eggs and puddings were added during the ninth month. At 1 year the children were receiving a general diet which included whole boiled milk, cereals, vegetables, soups, puddings, toast, eggs, bacon, stewed fruits, cod liver oil and orange juice" (8, p. 325).

Two groups were formed: a control series of 66 infants and an experimental series of 70 infants. The former "received the commonly used cereals," while the latter was fed "Mead's Cereal" - a mixture rich in vitamin B and minerals manufactured by Mead Johnson & Company. (The composition of the experimental cereal was as follows: "wheat meal (farina), 53 per cent; oatmeal, 15 per cent; bone meal, 2 per cent; dried brewer's yeast, 1 per cent; and alfalfa, 1 per cent." Its mineral content was "total ash, 3.2 per cent; calcium, 0.78 per cent; phosphorus, 0.02 per cent; iron, 0.024 per cent, and copper, 0.0013 per cent" (8, p. 324).) "All cereals were cooked with half milk and half water in a steam kettle for one-half hour and were fed as part of the morning meal. The quantity fed was dependent on the appetite of the child" (8, p. 325).

The subjects in each group were drawn "from the same social strata" and were "about equally divided as to sex" (8, p. 326). "There were 4 Negro children in each group" (8, p. 326). "Both groups were managed by the same nursing staff, and the diets differed only in the cereal given" (8, p. 325). On both groups the measurements of head girth were "made by the same physician," using a "steel tape" (8, p. 326). There were no subjects "with abnormalities of the head due to syphilis, rickets, hydrocephalus or microcephalus" (8, p. 331).

AVERAGE HEAD GIRTH (cm.) OF HEALTHY INSTITUTIONALIZED INFANTS ON CONTROLLED DIETS

Group	Months: 3	6	9	12	15	18	21
Experimental	39.4	41.7	43.6	44.0	45.0	46.7	47.7
Control	39.0	41.5	43.4	44.5	45.5	46.4	47.0

Blatt and Schapiro claimed they had compared "two groups of children in good health, living under as nearly ideal conditions as institutional life permitted," and found that "the group fed the special cereal mixture exceeded the control group in . . . circumference of head" (8, pp. 326, 336).

What are the implications of this study? It is the writer's view that the investigation presented no evidence in support of the inference that the special cereal mixture promoted growth in head girth. From the earliest age at which examinations were made through into the latter half of the second year, "the curves of the averages for both groups ran almost parallel" (8, p. 331). Moreover, as reported, the results cannot be considered to give dependable support to any statement regarding the relationship between growth in head girth and the vitamin and mineral content of the diet. This follows since no information was afforded on the numbers of subjects examined at each age, or on the numbers followed for six weeks only and for longer intervals to one year.

Central tendency and variability figures for head circumference were reported by Bakwin and Bakwin (2) in 1936 at eight ages during the first postnatal year. The data were obtained from 1,328 examinations made on 94 males and 104 females born at the Fifth Avenue Hospital, New York City, and "supervised from birth in a special clinic" for well infants. The subjects were characterized as White; mainly of North European, Mediterranean, and Jewish lineage; and "from homes of moderate income" (2, p. 177). Head girth was taken as "the largest circumference of the head."

HEAD GIRTH (cm.) OF NEW YORK CITY, MIDDLE CLASS, CLINIC SUPERVISED INFANTS

Age Group Midpoint (wks.)	Range	Males Mean	S.D.	V	Females Mean	S.D.	V
2	0 thru 3	35.4	1.47	4.1	34.8	1.39	4.0
6	4 thru 7	37.7	1.32	3.5	37.0	1.38	3.7
12	8 thru 15	39.0	1.34	3.5	38.9	1.32	3.4
20	16 thru 23	41.0	1.20	2.9	40.9	1.22	3.0
28	24 thru 31	43.6	1.19	2.7	42.4	1.20	2.8
36	32 thru 39	44.8	1.40	3.1	43.0	1.09	2.5
44	40 thru 47	45.9	1.21	2.6	44.5	1.27	2.9
52	48 thru 55	46.5	1.31	2.8	45.5	1.11	2.4

The investigators omitted enumeration of the number of subjects in each age-sex group. They stated that the data yielded "no consistent differences" for infants of North European, Mediterranean or Jewish ancestry.

Measurements of head circumference obtained on 202 full-term infants of Japanese parentage were analyzed by Ito (17) in 1936. The infants were born 1932-35 in Los Angeles, California. About one-fifth of the mothers were American-born and approximately 50 per cent primiparae. Their average age was 25.2 years. The fathers were "laborers, farmers, horticulturists, clerks, small merchants, public officials and professional men. The majority were of the laboring class, but were comparatively well-to-do for Japanese in California" (17, p. 321).

All the subjects were measured during the first week of postnatal life, "the majority being measured on the third, fourth or fifth day" (17, p. 321). "Greatest circumference of the head - corresponding to the plane of the occipitofrontal diameter" - was taken by means of "a metal tape . . . with a Gulick spring handle attachment" (17, pp. 322, 323). The tension of the spring in the handle attachment was balanced against the spring in the coil case of the tape.

HEAD GIRTH (cm.) OF NEONATES OF JAPANESE ANCESTRY AND "BELOW AVERAGE" CLASSES

Age Group Midpoint (days)	Age Group Range (days)	Sex	N	Mean	S.D.	V	Minimum	Maximum
4	0 - 7	Males	94	34.0	1.12	3.3	31.0	37.5
4	0 - 7	Females	108	33.8	1.24	3.7	28.0	37.0

For both sexes combined, the mean from this sample of Mongoloid infants was identical with that obtained by Montague and Hollingworth (23) from infants predominantly of White ancestry.

Joslin and Helms (18), in a 1937 paper, reported a study pertaining to the association between gain in head circumference and "amount of vitamin B complex in the diet" (18, p. 534). One hundred infants were followed "over a period of one year" through the pediatric clinic, University of Maryland, Baltimore. In initiating the study the infants were "placed alternately in two groups" as they were enrolled at the clinic. Both groups were "given the same basic diet, consisting of milk, water and carbohydrate, varied only as their ages demanded, with the addition of cereal and vegetables after six months of age" (18, p. 534). Their diets differed only in that one group received a special mixture of carbohydrate with vitamin B complex (Dextri-Maltose with vitamin B, manufactured by Mead Johnson & Company), while the other received "carbohydrate without additional vitamin B" (18, p. 535). The technique used in determining the head girth was not discussed.

VITAMIN B COMPLEX IN RELATION TO GAIN IN HEAD GIRTH (cm.) OVER ONE YEAR OF INFANCY

Vitamin B Group		Control Group		Vitamin B Gain minus Control Gain
N	Average	N	Average	
50	9.8	50	9.3	0.5

The difference in gain between the experimental and control groups was not tested for statistical significance. Consistent with this truncation of analysis, the investigators drew no conclusions claiming that growth of the head in infancy was increased "as the result of an increased amount of vitamin B complex given in the diet" (18, p. 538).

It was not made clear whether the experimental and control groups were matched for age. Each group was stated to have been followed for a year, but the year was not designated as extending from birth to twelve months of age. No more precise inference appears warranted than that the infants were probably under six months of age when accepted for study; this follows from the fact that their diets were started "when only milk and carbohydrate were being given" (18, p. 536). In the absence of explicit information on the age period(s) covered, and the extent to which the two groups were equated for age, the gains in head girth can neither be dependably interpreted nor compared with findings from other studies.

In 1938 Gesell and Thompson (12) published an analysis of head girth data representing each of the thirteen lunar month ages from eight to fifty-six postnatal weeks. Collection of the data took place 1927-31 at the Yale Clinic of Child Development, New Haven, Connecticut. The subjects - 40 males and 50 females - were "a normal, healthy, homogeneous group of white infants" (12, p. 11). All were full-term infants from "single births," 43 per cent being from "first pregnancies." All were "physically normal" and healthy. "Several cases of decided malnutrition were excluded" (12, p. 31). The parents were American-born and of "northern European extraction" (12, p. 28); they were "of the middle socio-economic status with respect to occupation, schooling, avocational interests, and home equipment" (12, p. 9) - their average years of schooling were 9.4 (fathers) and 9.8 (mothers), their intellectual and cultural interests were "near an average level"; in terms of Goodenough's six occupational categories they fell in categories III, IV, or V.

Head circumference was taken through "the glabella" anteriorly, and "the most prominent portion of the occiput" posteriorly. A steel tape was employed, its tautness being determined under the instruction "pull the tape until the first perceptible resistance is noticed" (12, p. 90). "With the exception of the infants less than 16 weeks of age" the measurements were "made by the same person" (Helen Thompson). As indicated previously, examinations were scheduled at lunar-month ages: "A variation of but two days from the exact age for each examination was the rule" (12, p. 9). "Some of the subjects were regularly and repeatedly examined, while others were seen only once" (12, p. 5).

HEAD GIRTH (cm.) OF NEW HAVEN "MIDDLE CLASS" INFANTS EXAMINED 1927-31.

Age (wks.)	Males N	Mean	S.D.	V	Range	Females N	Mean	S.D.	V	Range
8	14	39.0	1.23	3.2	36.2-40.6	12	38.1	0.99	2.6	36.5-39.5
12	12	40.5	0.94	2.3	38.9-42.0	13	39.1	1.06	2.7	37.3-40.6
24	16	43.5	0.96	2.2	41.7-44.9	21	41.9	1.10	2.6	39.9-43.2
28	15	44.2	0.81	1.8	43.2-45.0	18	42.4	0.93	2.2	41.0-44.4
40	20	46.1'	1.16	2.5	44.1-48.0	17	44.0	1.22	2.8	42.3-46.6
52	19	47.3	0.85	1.8	45.4-48.5	24	45.0	1.06	2.4	43.3-47.9

	Increase in Mean				
	Twelve-week intervals:				Forty-eight wk. interval
	8-20	20-32	32-44	44-56	0-56
Absolute: Males	3.44	2.69	1.23	0.09	8.25
Females	3.12	2.07	1.25	1.26	7.70
Percentage: Males	8.8	6.8	2.7	1.9	21.1
Females	8.2	5.0	2.9	2.8	20.2

The differences between the means for successive twelve-week intervals were found to reflect a decreasing rate of growth with age.

In a 1930 study on the question of whether or not "constitution is a factor in the etiology of eczema in infants," Bakwin and Bakwin (3) compared the head girths of 126 eczematous infants and 775 control infants. Each group consisted of New York City White infants of mixed ethnic descent "from the same social economic environment" - "a low income one" (3, p. 270). The control subjects "were admitted to Bellevue Hospital as healthy boarders or because of mild upper respiratory infections and had received no regular medical supervision before admission" (3, p. 270). The experimental subjects were "infants with typical facial eczema . . . obtained from the wards or Out Patient Department of Bellevue Hospital" (3, p. 270). There were 433 males and 342 females in the control series, 86 males and 40 females in the experimental series. Head girth was taken as "the largest circumference of the head."

For the experimental data, there were few records at any one age; consequently, a method of analysis was sought which would avoid "the necessity of dividing up the material into age groups" (3, p. 269). Two graphs were constructed - one for males and the other for females - covering the first postnatal year. On each graph were plotted three trend lines derived from the control data: one drawn through mean values and the other two through points one standard deviation above and below the means. The records for infants with eczema were then spotted on these charts and tallied in terms of the zones within which they fell.

HEAD GIRTH DATA FOR INFANTS WITH ECZEMA [illegible] DISTRIBUTIONS [illegible] CONTROL SERIES

	-3 S.D. to -1 S.D.		-1 S.D. to Mean		Mean to +1 S.D.		+1 S.D. to +3 S.D.	
	N	%	N	%	N	%	N	%
Males	13	15	22	26	28	32	23	27
Females	6	15	9	23	13	33	12	[illegible]
Both sexes	19	15	31	25	41	32	35	[illegible]

Computation of chi-square showed the experimental data to differ significantly from the control data; accordingly, the conclusion was drawn that the infants with eczema were "larger" in head girth than the non-eczematous infants.

The head girth data analyzed by Stuart (28) in 1934 were extended and re-analyzed by Vickers and Stuart (34) in 1943. It will be recalled that accumulation of the data began in 1930 as part of a long-term study under the auspices of the Center for Research in Child Health and Development, Harvard University. The subjects "were principally of Northern European stock (a large proportion Irish), and the majority . . . were brought up in the vicinity of Boston in homes of low to middle economic circumstances" (34, p. 156). "Prematurely born infants and defective or chronically ill children were excluded" (34, p. 169). With few exceptions, the subjects were examined "repeatedly at fixed intervals"; examinations were made shortly following birth, within five days of ages three, six and nine months, and within approximately one week of ages twelve, eighteen and twenty-four months. Each examination included a comprehensive pediatric evaluation and supplied the parents with "health and nutritional advice."

HEAD GIRTH (cm.) OF BOSTON MIDDLE CLASS INFANTS UNDER PEDIATRIC GUIDANCE

Age (mos.)	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
Birth	99	35.3	1.2	3.4	32.5	33.5	34.4	35.3	36.2	37.0	38.0
3	125	40.8	1.2	2.9	38.2	39.2	40.0	40.8	41.5	42.1	44.5
6	117	44.0	1.0	2.3	41.8	42.7	43.3	43.9	44.6	45.4	46.5
9	115	45.0	1.0	2.2	43.1	44.5	45.1	46.0	46.5	47.1	49.0
12	113	47.1	1.1	2.3	43.4	46.5	46.5	47.3	47.8	48.4	49.5
18	108	48.8	1.1	2.3	46.2	47.3	48.0	48.8	49.4	50.1	51.0
24	102	49.6	1.2	2.4	46.0	48.1	48.7	50.0	50.4	51.2	52.0
					Females						
Birth	110	34.7	1.0	2.9	31.0	33.4	33.9	34.7	35.4	35.0	37.2
3	121	40.0	1.2	3.0	37.0	38.5	39.2	40.0	40.8	41.7	42.0
6	131	42.9	1.2	2.8	40.2	41.4	42.0	42.8	43.6	44.5	46.8
9	121	44.7	1.2	2.7	42.1	43.2	43.8	44.6	45.4	46.3	47.9
12	121	45.9	1.3	2.8	43.2	44.3	45.0	45.6	46.7	47.7	49.1
18	107	47.4	1.2	2.5	43.9	45.8	46.5	47.3	48.5	49.1	50.2
24	104	48.2	1.4	2.9	45.5	46.8	47.1	48.1	49.1	50.2	51.4

In measuring the head circumference, a cloth tape (checked frequently against a standard) was passed "over the most prominent part of the occiput and just above the supraorbital ridges" (34, p. 169).

A study was made by Meredith (21) in 1944 utilizing data for head girth accumulated over the decade 1930 through 1939 from developmental examinations of physically normal infants. The subjects were 1,050 White infants - 563 males and 487 females - ranging in age from two months to two years. They were almost all residents of Iowa City, Iowa, and upwards of 90 per cent were of northwest European ancestry. Information on occupation of the fathers showed 46 per cent to represent the professional and managerial classes, 28 per cent the skilled trades, and 26 per cent the unskilled and semiskilled groups.

The data were collected by, or in accordance with the technique of, Dr. Helen L. Dawson. A steel millimeter tape was placed around the infant's head by the anthropometrist ("measurer") and, with the aid of an assistant, adjusted "posteriorly over that part of the occiput which was farthest from the glabella. While the assistant held the tape in place posteriorly, the measurer adjusted it anteriorly above the supraorbital ridges, drew it tight, and read the measurement" (21, p. 199). In statistical reduction of the data, central tendency and variability findings were obtained at age two months, and at successive quarterly ages from three to twenty-four months. Only those head circumference records were accepted for tabulation which fell within five days of ages two and three months, and within seven days of the successive quarter-year ages.

HEAD GIRTH (cm.) OF IOWA INFANTS OF MIDDLE AND UPPER CLASSES STUDIED 1930-39

Age (mos.)	N	Mean	S.D.	V	Minimum	Percentiles 10	25	50	75	90	Maximum
					Males						
3	35	39.0	1.00	2.6	36.5	...	38.2	...	39.7	...	41.0
6	112	40.6	1.05	2.6	37.0	39.2	40.0	40.6	41.2	41.8	43.6
9	205	43.7	1.20	2.8	40.4	42.2	42.9	43.7	44.5	45.4	47.2
0	249	45.6	1.24	2.7	42.6	44.1	44.7	45.5	46.4	47.2	49.2
12	258	46.0	1.29	2.8	43.6	45.1	45.9	46.7	47.6	48.5	50.8
15	225	47.6	1.24	2.6	44.8	46.1	46.7	47.6	48.5	49.2	51.1
18	204	48.5	1.22	2.5	45.8	46.7	47.5	48.3	49.1	49.9	51.7
21	170	48.8	1.21	2.5	46.2	47.2	47.9	48.8	49.6	50.4	52.0
24	186	49.3	1.19	2.4	46.7	47.9	48.4	49.3	50.2	50.9	52.3
					Females						
3	25	38.2	1.34	3.5	35.8	...	37.3	...	39.0	...	40.5
6	93	39.4	1.24	3.1	36.5	37.9	38.7	39.4	40.2	41.0	42.1
9	180	42.4	1.28	3.0	38.8	40.8	41.6	42.4	43.2	44.0	45.2
9	228	44.2	1.19	2.7	41.1	42.8	43.3	44.2	45.0	45.8	47.2
12	230	45.4	1.23	2.8	42.5	43.8	44.4	45.4	46.5	47.2	48.5
15	212	46.2	1.23	2.7	43.2	44.6	45.4	46.2	47.1	47.9	49.0
18	204	47.0	1.23	2.6	43.9	45.5	46.0	46.9	47.6	48.0	49.6
21	164	47.5	1.25	2.6	44.5	45.8	46.6	47.5	48.5	49.1	50.4
24	185	48.0	1.21	2.5	45.0	46.4	47.1	48.0	48.9	49.6	51.0

Over the age period from three months to two years, supplementary means were obtained for both sexes combined. These values were used to derive age-to-age increments and thereby portray the trend in rate of growth.

HEAD GIRTH MEANS (cm.) FOR BOTH SEXES COMBINED, TOGETHER WITH QUARTERLY INCREASES IN MEAN HEAD GIRTH

Age (mos.)	N	Mean	Increase in Mean: Absolute	Increase in Mean: Percentage
3	205	40.07		
6	505	43.08	3.01	7.5
9	475	44.91	1.83	4.2
12	490	46.09	1.18	2.6
15	437	46.94	0.85	1.8
18	400	47.60	0.66	1.4
21	334	48.16	0.56	1.2
24	351	48.67	0.51	1.1

Mean head girth at one year exceeded mean head girth at six months by 3.0 cm., or 7.0 per cent. Between ages one and one-half and two years, corresponding increments were 1.1 cm. and 2.2 per cent.

In 1945 Boyd (7) published an analysis of serial records for head circumference obtained on 100 "presumably normal" infants - 81 males and 19 females - housed in the metabolism ward of the Department of Pediatrics, University Hospitals, Iowa City. "All subjects were of the white native stock" (7, p. 71). "The majority were first-born children . . . of unmarried mothers" (7, p. 71). They were "recruited mostly from orphanages or from the maternity ward of the obstetric service of the State University of Iowa. . . . A significant number, however, were children of young university student couples, placed in the hospital because the mothers desired to continue employment outside the home" (7, p. 71). While various regimens of diet were employed, each was "designed to meet good standards of infant nutrition except for an experimental variation in the amount of vitamin D" (7, p. 71).

"Head circumference was determined through the use of a steel tape measure passed over the greatest prominence of the occiput and of the glabella" (7, p. 71). "Measurements were made by graduate nurses . . . trained in anthropometric technics" (7, p. 71).

HEAD GIRTH (cm.) OF IOWA INFANTS LIVING UNDER CONTROLLED CONDITIONS OF HOUSING AND DIET

Midpoint of Age Group (mos.)	Males				Females			
	N	Mean	S.D.	V	N	Mean	S.D.	V
1	55	36.0	1.4	3.9	15	35.0	0.8	2.3
2	65	38.4	1.4	3.6	17	37.2	1.3	3.4
3	71	39.5	1.4	3.5	18	38.5	1.2	3.1
6	64	42.4	1.2	2.7	13	41.2	0.8	1.9
9	24	44.3	1.1	2.5	4	42.7		
12	24	45.5	1.2	2.6	4	44.9		

The average difference between the means for males and females was found to be 1.0 cm. For males, the mean at one year exceeded the mean at one month by 9.5 cm., or 26.4 per cent.

An analysis of head girth data on 233 male infants, 134 White and 99 Negro, was reported in 1945 by Rhoads, Rapoport, Kennedy and Stokes (25). The data were collected between 1936 and 1940 through the "Out-Patient Department of the Children's Hospital of Philadelphia," each subject being measured at ages three months, one year, and two years. Infants were "classed as Negro where they had any known trace of Negro blood" (25, p. 437); the White infants were "in large proportion of northern European stock, with approximately one-fourth of Italian descent" (25, p. 416). All infants "had birth weights of 5 pounds or more," resided in urban families of "low socio-economic level," and were given dietary supervision beginning at the average age of six postnatal weeks.

From the time of the first examination all subjects received evaporated milk and orange or tomato juice. At six months the dietary included "banana, cereal, and pureed vegetables and fruits, and at 1 year, potato, meat, and egg" (25, p. 417). Four dietary subgroups were formed - the objective in this was to determine the influence of supplements of vitamins D, A, and B complex on the head girth of infants fed evaporated milk as their sole milk supply. Groups I, II, and III received "110 U.S.P. units of vitamin D daily in the form of irradiated evaporated milk"; Groups II and III also were given approximately 2,250 U.S.P. units of vitamin A daily in ten drops of carotene; and Group III received roughly 250 units of vitamin B_1 and 250 Sherman units of vitamin B_2 daily through the medium of brewer's yeast powder. Group IV was fed "nonirradiated evaporated milk plus 3 teaspoons of cod-liver oil daily" (25, p. 418). For all groups, visits were made to the homes every two weeks "in order to deliver the evaporated milk and vitamin supplements, and to keep in touch with the home care of the child" (25, p. 417).

There was no discussion of anthropmetric technique beyond a statement indicating that the procedure followed was the same as that of Vickers and Stuart (34), l. c., a cloth tape was passed over the most prominent part of the occiput and just above the supraorbital ridges.

HEAD GIRTH (cm.) OF PHILADELPHIA MALE INFANTS FROM "LOW INCOME" FAMILIES GIVEN DIETARY SUPERVISION

Group	N	3 mos.		12 mos.		24 mos.		Increment (3 to 24 mos.)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Absolute	% age
				White Males					
I	48	40.0	1.37	46.4	1.50	48.8	1.45	8.0	22.0
II	24	40.1	1.09	46.3	1.14	48.7	1.34	8.6	21.4
III	20	39.7	1.50	46.3	1.39	48.8	1.45	9.1	22.9
IV	42	39.9	1.06	46.4	.94	49.0	.97	9.1	22.8
Total	134	39.9	1.27	46.4	1.27	48.8	1.30	8.9	22.3
				Negro Males					
I	32	39.8	1.14	46.1	1.42	48.4	1.24	8.6	21.6
II	17	40.1	1.30	46.5	1.14	48.9	1.52	8.8	21.9
III	19	39.7	1.08	46.1	.86	48.7	1.05	9.0	22.7
IV	31	39.8	1.58	46.1	1.83	48.4	1.85	8.6	21.6
Total	99	39.8	1.31	46.2	1.50	48.5	1.49	8.7	21.9

No statistically significant differences in head girth were found between any of the dietary subgroups at ages three months, one year, or two years. For the four dietary subgroups combined, at no age was the difference between the two racial groups of sufficient magnitude to support the inference that the White and Negro data represented random samples drawn from unlike head girth populations. On the total series of White males, the increase in mean head girth over the period from three months to two years was 8.9 cm., or 22.3 per cent; the corresponding values from the total series of Negro males were 8.7 cm. and 21.9 per cent.

Head girth data accumulated by the Child Research Council, University of Colorado, were made available in 1945 by Washburn and Redfield (35). The data represented measurements of fronto-occipital circumference on "average healthy" Denver infants examined repeatedly. They were collected between 1932 and 1944 on 54 males and 66 females, almost all of whom were of northwest European ancestry. Upwards of 90 per cent of the parents and 70 per cent of the grandparents were American-born. Around 30 per cent of the fathers placed in the professional or managerial groups, 60 per cent in the minor managerial or skilled trades groups, and 10 per cent among the semiskilled or unskilled.

HEAD GIRTH (cm.) OF DENVER INFANTS OF MIDDLE AND UPPER CLASSES

Age (mos.)	N	Mean	S.D.	V	Percentiles 25th	Percentiles 75th	Range
				Males			
Birth	9	34.7	...	...	...	...	33.0 - 36.0
1	20	37.2	1.3	3.6	36.5	37.9	34.6 - 39.3
2	19	38.8	1.2	3.0	38.2	39.0	36.2 - 40.0
3	35	40.4	1.2	3.0	39.7	41.3	38.3 - 42.6
6	42	43.4	1.2	2.7	42.6	44.2	41.0 - 46.3
9	36	45.3	1.0	2.2	44.7	46.1	43.0 - 47.1
12	40	46.6	1.0	2.1	46.0	47.3	44.2 - 49.2
18	41	48.3	0.8	1.7	47.9	48.9	45.8 - 50.0
24	40	49.3	0.9	1.8	48.7	49.9	47.6 - 50.9
				Females			
Birth	12	34.0	...	...	...	...	32.4 - 35.9
1	20	36.4	1.0	2.7	36.0	36.9	34.0 - 38.3
2	22	37.8	0.8	2.0	37.3	38.4	36.0 - 39.2
3	40	39.4	1.0	2.4	38.7	40.0	37.1 - 41.2
6	41	42.4	1.0	2.4	41.7	43.0	39.9 - 44.4
9	39	44.2	1.2	2.7	43.5	45.1	41.3 - 46.5
12	42	45.5	1.2	2.7	44.6	46.4	42.4 - 48.0
18	39	47.0	1.4	3.1	46.1	48.0	43.4 - 49.8
24	38	47.9	1.4	3.0	47.0	49.1	44.2 - 50.5

The means at two years of age exceeded those at birth by 14.6 cm. for males and 13.9 cm. for females. On each sex, the largest record at birth was practically equivalent to the smallest at age two months; similarly the largest record at three months was of nearly equal magnitude with the smallest at nine months.

Anthropometric Technique

Before turning to the problem of integrating the available materials for head girth on groups of North American infants, it is pertinent to interpose a discussion of anthropometric technique. How closely do the various series of data aggregated in the foregoing section approximate anthropometric comparability? Is it known, or can it be assumed, that in each study

reasonably careful attention was given to specification and rigorous application of the method of measurement and, consequently, to the dependability of the records amassed? Which collections of data represent a common procedure with respect to the anthropometric landmarks used and the tautness of the tape?

For seventeen of the thirty-five investigations there was little or no description of technique: Six indicated only that their data represented "cranial circumference" or "head girth" (6, 10, 18, 19, 22, 24); six used the designation "occipitofrontal circumference" (11, 14, 15, 23, 32, 36); and five stated that the "maximum girth" or "greatest circumference" had been measured (1, 2, 3, 4, 13).

Each of the other eighteen investigations made some direct reference to the landmarks employed. The posterior landmark was usually "the greatest prominence of the occiput" (5, 7, 8, 12, 16, 17, 21, 25, 26, 27, 28, 29, 34, 35). One investigator used "a point just above the external occipital protuberance" (9) and three studies were no more specific than "occiput" (30, 31, 33). There was less consistency regarding the anterior landmark(s). Several investigators measured "through the frontal eminences" (26, 29, 30, 31) and several "through the glabella" (7, 8, 9, 12, 17, 33).[1] It appears beyond doubt that the descriptions "over the greatest prominences in the temporal and frontal regions" (5, 16, 27) corresponded in practice with the descriptions "through the frontal eminences"; similarly, in instances where the anterior landmark was defined with reference to the supraorbital ridges (21, 25, 28, 34) the tape must have been passed in the region of the glabella. In two investigations, the same series of head girth data were described as having been taken "through the supraorbital ridges" (28) and "just above the supraorbital ridges" (34).[2]

[1] *In order to obtain an indication of the comparability of these landmarks during infancy, the writer made measurements at both levels on each of 50 White infants - 25 between 6 and 9 months of age and 25 between 18 and 24 months. It was found that mean head circumference "through the greatest prominence of the occiput and the frontal eminences" exceeded mean head circumference "through the greatest prominence of the occiput and the glabella" by 0.3 cm. on the younger group and by 0.4 cm. on the older group.*

[2] *Attention is called to the ambiguity of the words "above" and "over" in describing certain landmarks. With reference to the supraorbital ridges, these words may be interpreted as implying either "anterior" to the ridges or "superior" to them.*

Only seven of the available investigations discussed the tautness of the tape at the time head girth readings were made. In three instances "very slight" pressure was used (8, 12, 33) and in three the tape was drawn tightly (5, 17, 21). The seventh study was apparently intermediate, the tape having been brought "snugly" in contact with the head (29).

It need not be labored that in dealing with all problems of inter-comparison and colligation encompassed in the "Synthesis of Source Materials" which follows, the writer has made due allowance for the uncertainties and variations pertaining to the data. In this connection, those who make studies which involve pooling materials from different laboratories in order to derive comprehensive portrayals of the status of given sectors of knowledge become keenly aware of the need for moving toward anthropometric methods that are at once well-specified and standardized.

Synthesis of Source Materials

The initial step taken in synthesizing the source materials was that of compiling Tables 1 to 8. These tables afford an ordered display of the available averages for head circumference (exclusive of those on groups of infants born prematurely or having a specific disease) at eleven selected ages. Each average listed will be seen to represent infants of both sexes and to be accompanied by an abridged identification of the sample from which it was derived.

Average head circumference of nonpathologic White infants

In approaching this problem, two leading questions were asked: At each of several appropriately spaced ages, what is the average head circumference for physically normal White infants studied in North America to date? Over different age intervals, how much does the typical North American White infant increase in head circumference?

Answers to these questions were sought by pooling materials in Tables 1 to 8. Composite means were calculated representing monthly ages between birth and three months, quarterly ages from three months to one year, and semiannual ages between one and two years. At a particular age, the procedure followed was that of multiplying each average by the number of measures on which it was based, and dividing the sum of the resultant

TABLE 3

HEAD CIRCUMFERENCE AT AGE THREE MONTHS (Centimeters): Central tendency (mean or median) values from sixteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Chapin (1894)	37.7	27	New York	c.1894	Probably White	"Hospital cases," many "much below par;" measured at ages 1 to 5 mos.
Fleischner (1906)	38.0	c.75	New York	Before 1906	. . .	"Hospital patients," rated 40% "poorly nourished," some premature.
Grover (1915)	38.1	16	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Talbot (1924)	38.9	c.35	Massachusetts	c.1915-17	White	"Average . . . normal, healthy" infants; mostly breast-fed.
Blatt and Schapiro (1935)	39.2	c.65	Illinois	1931-33	Mainly White, few Negro	Normal, "well" infants; fed a controlled (whole milk) diet.
Boyd (1945)	39.2	87	Iowa	1930-44	White	"Normal babies;" mainly fed a diet controlled to meet "good standards."
Baldwin and Baldwin (1936)	39.7	c.175	New York	c.1929-35	White	From "homes of moderate income;" mothers advised on infant care.
Richdorf (1925)	39.9	109	Minnesota	c.1924	Mainly North European	From middle and upper classes, pediatric guidance was available.
Washburn and Reddield (1945)	39.9	75	Colorado	1932-44	North European	Mainly middle and upper classes, normal subjects examined at age three months.
Iowa Child Welfare Research Station (1931)	40.1	34	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Gesell and Thompson (1938)	40.1	31	Connecticut	1927-31	North European	Of "middle socio-economic status," physically normal and healthy.
Meredith (1964)	40.1	205	Iowa	1930-39	Mainly North European	Iowa City infants drawn predominantly from the middle and upper classes.
Vickers and Stuart (1943)	40.4	246	Massachusetts	1930-42	Mainly North European	From middle and lower classes, mothers advised on infant care.
Baldwin, Fillmore and Radley (1932)	40.5	28	Iowa	1923-26	North European	From rural areas of east-central Iowa, measured at ages birth to 6 mos.
Stuart (1934)	40.5	119	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes, given pediatric guidance from birth.
Bayley and Davis (1935)	40.9	60	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

TABLE 4

HEAD CIRCUMFERENCE AT AGE SIX MONTHS (*Centimeters*): Central tendency (mean or median) values from twenty-one analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Chapin (1894)	38.9	9	New York	c.1894	Probably White	See Table 3: ages 5 to 7 mos.
Fleischner (1906)	40.6	c.75	New York	1905 (?)	. . .	See Table 3.
Blatt and Schapiro (1935)	41.6	c.45	Illinois	1931-33	Mainly White, few Negro	"Well" infants, fed supplementary foods for vitamins D, C and B.
Boyd (1945)	42.0	77	Iowa	1930-44	White	See Table 3.
Grover (1915)	42.1	25	Massachusetts	1914 (?)	Probably White	See Table 3.
Talbot (1924)	42.5	c.50	Massachusetts	c.1915-17	White	See Table 3.
Baldwin and Baldwin (1936)	42.6	c.160	New York	c.1929-35	White	From middle classes; advised at a clinic on diet and health care.
Holt and Howland (1919)	42.8	c.200	New York Maryland (?)	Before 1919	Probably White	"Healthy" infants, probably seen in private pediatric practice.
Mohr and Bartelme (1934)	42.8	7	Illinois	1929-33	White	60% North European, from "a slightly inferior socio-economic group."
Holt (1897)	42.9	...	New York	Before 1897	Probably White	Data on normal, healthy infants; probably gathered in private practice.
Hechdorf (1925)	42.9	100	Minnesota	c.1924	Mainly N. Eur.	See Table 3.
Washburn and Redfield (1945)	42.9	83	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age six months.
Gesell and Thompson (1938)	43.0	35	Connecticut	1927-31	North European	Of "middle socio-economic status," physically normal and healthy.
Meredith (1944)	43.1	345	Iowa	1930-39	Mainly N. Eur.	See Table 3
Baldwin, Fillmore and Hadley (1930)	43.2	42	Iowa	1923-26	North European	Subjects resided in rural areas of east-central Iowa.
Pickers and Stuart (1943)	43.4	248	Massachusetts	1930-42	Mainly North European	From middle and lower classes, mothers advised on infant care.
Cruz (1916)	43.6	435	Numerous	1913-16	Mainly N. Eur.	Baby show and health conference data
Iowa Child Welfare Research Station (1931)	43.7	59	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Stuart (1934)	43.9	102	Massachusetts	1930-34	North European	See Table 3.
Bayley and Davis (1935)	44.1	59	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished
Macy (1911)	44.2	c.100	New York (?)	1911 (?)	Probably White	Considered to typify age 6 mos.

TABLE 5

HEAD CIRCUMFERENCE AT AGE NINE MONTHS (Centimeters): Central tendency (mean or median) values from sixteen analyses of data obtained on full-term infants of both sexes. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Chapin (1894)	42.1	13	New York	c.1894	Probably White	"Hospital cases," many "much below par," measured at 7 to 11 mos.
Fleischner (1906)	42.6	c.75	New York	Before 1906	. . .	"Hospital patients," rated 40% "poorly nourished." some premature.
Blatt and Schapiro (1935)	43.5	c.45	Illinois	1931-33	Mainly White, few Negro	"Well" infants; fed whole milk plus other foods for vitamins and minerals.
Boyd (1945)	43.9	28	Iowa	1930-44	White	"Normal babies;" mainly fed a diet controlled to meet "good standards."
Baldwin and Baldwin (1936)	44.7	c.140	New York	c.1929-35	White	From "homes of moderate income;" mothers advised on infant care.
Washburn and Redfield (1945)	44.7	77	Colorado	1932-44	North European	Mainly middle and upper classes, normal subjects examined at age nine months.
Iowa Child Welfare Research Station (1931)	44.9	56	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Weir and Bartelme (1934)	44.9	5	Illinois	1929-33	White	60% North European, from "a slightly inferior socio-economic group."
Gesell and Thompson (1938)	44.9	34	Connecticut	1927-31	North European	Of "middle socio-economic status," physically normal and healthy
Meredith (1944)	44.9	475	Iowa	1932-39	Mainly North European	Iowa City infants drawn predominantly from the middle and upper classes
Richdorf (1925)	45.1	95	Minnesota	c.1924	Mainly North European	From middle and upper classes, pediatric guidance made available.
Baldwin, Fillmore and Hadley (1930)	45.2	57	Iowa	1923-28	North European	From rural areas of east-central Iowa, measured at ages 6 to 12 mos.
Vickers and Stuart (1943)	45.2	236	Massachusetts	1930-42	Mainly North European	From middle and lower classes, mothers advised on infant care.
Crum (1916)	45.3	304	Rochester	1913-15	Mainly North European	Infants measured at baby contests and health conferences.
Stuart (1946)	45.3	91	Massachusetts	1930-34	North European, 50% Irish	Largely from middle classes, given pediatric guidance from birth.
Bayley and Davis (1935)	46.2	58	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

TABLE 6

HEAD CIRCUMFERENCE AT AGE ONE YEAR (Centimeters): Central tendency (mean or median) values from nineteen analyses of data obtained on *full-term infants of both sexes*. Each value is supplemented with an itemization of major characteristics of the sample.

Investigator	Average	Number	State	Period	Ancestry	Other Characteristics of Sample
Fleischner (1906)	44.1	c.75	New York	1905 (?)	. . .	See Table 5.
Blatt and Schapiro (1935)	44.7	c 45	Illinois	1931-33	Mainly White, few Negro	"Well" infants: fed whole milk plus other foods for vitamins, minerals.
Grover (1915)	44.8	23	Massachusetts	Before 1915	Probably White	Mostly "out-patients," some "private," some "bed patients;" all "normal."
Chapin (1894)	44.9	6	New York	c.1894	Probably White	See Table 5, ages 11 to 13 mos.
Macy (1912)	45.0	c.100	Probably New York	Before 1912	. . .	Sample considered representative of normal infants at age one year.
Holt and Howland (1919)	45.1	c.200	New York Maryland (?)	Before 1919	Probably White	"Healthy" infants, probably seen in private pediatric practice.
Boyd (1945)	45.2	28	Iowa	1930-44	White	See Table 5.
Holt (1897)	45.3	---	New York	Before 1897	Probably White	Data on normal, healthy infants; probably gathered in private practice.
Baldwin and Baldwin (1936)	46.0	c.120	New York	c.1929-35	White	From "homes of moderate income;" mothers advised on infant care.
Gesell and Thompson (1938)	46.0	43	Connecticut	1927-31	North European	Of "middle socio-economic status," physically normal and healthy.
Washburn and Redfield (1945)	46.0	82	Colorado	1932-44	North European	Mainly middle and upper classes; normal subjects examined at age one year.
Meredith (1964)	46.1	496	Iowa	1930-39	Mainly N. Eur.	See Table 5.
Baldwin, Pallmeyer and Hadley (1930)	46.2	56	Iowa	1923-25	North European	Subjects resided in rural areas of east-central Iowa.
Iowa Child Welfare Research Station (1931)	46.3	51	Iowa	1920-29	Mainly North European	Data obtained at well-baby clinics in urban areas of east-central Iowa.
Talbot (1924)	46.4	c.40	Massachusetts	c.1915-17	White	Subjects "clinically normal."
Stuart (1934)	46.5	85	Massachusetts	1930-34	North European	See Table 5
Vickers and Stuart (1943)	46.5	234	Massachusetts	1930-42	Mainly North European	From middle and lower classes; given pediatric guidance from birth.
Crum (1918)	46.6	512	Numerous	1913-16	Mainly N. Eur.	See Table 5.
Bayley and Davis (1935)	47.6	55	California	1928-30	Mainly North European	From middle and upper classes, reasonably healthy and well nourished.

products by the total number of the measures.[3] Exclusions were made to avoid any duplicate use of measures and to eliminate studies on non-White infants. The specific omissions were as follows: For Table 1, Holt and Howland (1919), Stuart (1934) and Ito (1936); for Tables 3 and 5, Stuart (1934); for Tables 4, 6, 7 and 8, Holt (1897) and Stuart (1934). In Table 1 the number of measures for Williams' study was taken as 150. Table 9 gives the composite means obtained, together with the increases in mean for varying age intervals.

TABLE 9

HEAD CIRCUMFERENCE (Centimeters): Composite central tendency values for White infants of both sexes studied in North America during the period of 1890-1945, also increases in central tendency over specified age intervals.

Age (mos.)	Number	Mean	Increments: Monthly	Quarterly	Semi-annual	Annual
Birth	5226	34.3				
1	195	36.6	2.3			
2	295	38.6	2.0			
3	1239	39.9	1.3	5.6		
6	2193	43.0		3.1	8.7	
9	1791	44.9		1.9		
12	2166	46.0		1.1	3.0	11.7
18	1611	47.6			1.6	
24	1471	48.7			1.1	2.7

Selected findings from this table are:

1. Mean head circumference increases from 34.3 cm. (13.5 in.) at birth, through 46.0 cm. (18.1 in.) at one year of age, to 48.7 cm. (19.2 in.) at age two years. With reference to magnitude at birth, the increases are 11.7 cm. (4.6 in.), or 34 per cent, during the first postnatal year, and 14.4 cm. (5.7 in.), or 42 per cent, during the first two postnatal years.

2. Girth of head increases at a gradually slowing rate between birth and two years of age. The increase in mean for the first postnatal month is greater than that from six to nine

[3] In mathematic symbolism, the formula used was

$$M_c = \frac{N_1M_1 + N_2M_2 + \ldots + N_vM_v}{N_1 + N_2 + \ldots + N_v}$$

In which M represents arithmetic mean, N represents number of measures, subscript c refers to a combined or composite sample, and the numerical subscripts designate component samples.

months; similarly, the increase during the quarter-year from three to six months is greater than that for the entire second year. In percentage terms, the mean at one month exceeds the mean at birth by a larger amount (6.7 per cent) than the mean at two years exceeds that at one year (5.9 per cent).

These findings provoke a further question: Is there a simple mathematic relationship in infancy between age and average head circumference? Employing curve-fitting procedures, a noncomplex algebraic equation was sought which would closely "fit" the series of means at different ages shown in Table 9. It was found that for the period from one month to two years the data were best graduated by the empirical equation

$$\text{Head girth} = 36.36 \times .0933^{x}$$

in which "x" symbolizes "postnatal age in months." An indication of the "goodness of fit" is afforded by the following tabulation:

	Age in Months:				
	1	6	12	18	24
Obtained means (from Table 9)	36.6	43.0	46.0	47.6	48.7
Predicted means (from equation)	36.4	43.0	45.9	47.6	48.9
Difference	- 0.2	0.0	- 0.1	0.0	+ 0.2

Secular differences in head circumference

In the case of infant stature, it is known that over the past several decades the direction of the secular trend has been upward in North America. A recent examination of stature materials has led to the conclusion, "the average two-year-old child may be taken as at least four centimeters (one and one-half inches) taller for 1940 than for 1880" (20, p. 15). Has there been a parallel increase in head circumference? Casting the question in a form specifically suited to the available data, is there a difference in head girth between those infants studied prior to 1927 and those studied 1927-1945?

For consideration of this problem, the frame of reference was again restricted to full-term, nonpathologic, White infants. In addition, analyses were carried out only at ages affording no less than 500 measures for each period.

Utilizing Table 1 and Tables 4 to 8, composite means for the periods 1890-1926 and 1927-1945 were secured at each of six ages. In amassing the studies at a given age according to the period in which their data were collected, rejections were made to avoid duplicate use of records and to eliminate studies using records accumulated partly in each period. For Table 1, the

rejections were Holt and Howland (1919) Stuart (1934) and Ito (1936); for Tables 4, 6, 7 and 8, Holt (1897), Stuart (1934) and Iowa Child Welfare Research Station (1931); for Table 5, Stuart (1934) and Iowa Child Welfare Research Station (1931). The composite values obtained are presented in Table 10.

TABLE 10

HEAD CIRCUMFERENCE (Centimeters): Composite means for White infants of both sexes studied in North America during the periods 1890-1926 and 1927-1945.

Age (mos.)	1890-1926 Number	1890-1926 Mean	1927-1945 Number	1927-1945 Mean	Later Mean − Earlier Mean	Significance Ratio (t)
Birth	2982	34.2	2244	34.3	0.1	1.4*
6	1036	43.1	1098	43.0	− 0.1	1.3
9	637	44.9	1098	44.9	0.0	...
12	1012	45.9	1103	46.2	0.3	4.3
18	770	47.5	805	47.8	0.3	3.8
24	749	48.6	682	48.8	0.2	2.8

*Computation of these ratios necessitated estimates of the variability of head girth. Composite standard deviations were calculated for each age using all of the standard deviations on samples of White infants reported. For a statement of the formula employed see footnote 10. The composite figures derived -- representing White infants of both sexes -- were 1.5 cm. at birth (N = 4,765) and three months (N = 1,161); 1.4 cm. at six (N = 1,204) and nine (N = 1,253) months; 1.5 cm. at twelve (N = 1,295) and eighteen (N = 824) months; and 1.4 cm. at twenty-four months (N = 896). At a given age, the composite sigma was taken to depict the variability in each secular period.

It will be seen that:

1. During the first year of postnatal life, there is no systematic difference in head girth between those infants studied in the period 1890-1926 and those studied in the period 1927-1945.

2. For the second postnatal year, infants measured between 1927 and 1945 tend to be slightly larger in head girth than infants measured 1890-1926. While the differences are small - at no age exceeding 0.3 cm. (one-eighth inch) - they are consistent in direction and statistically significant (t exceeds 2.8 in each instance).

The reader is cautioned that these findings must not be glibly interpreted as paralleling those established for stature. The maximum difference of 0.3 cm. in head girth is no more than one-tenth the stature difference over the same secular interval. This markedly smaller magnitude of head girth differences, together with the incomplete description of many series of data, makes it impossible to distinguish the operation of differential factors associated with secular period from the presence of slight sampling differences for the two periods in such variables as ethnic and socio-economic composition or anthropometric

technique. For example, it cannot be shown unequivocally that factors associated with secular period are either (a) overshadowed by uncontrolled variables at age nine months, or (b) responsible for the difference obtained at one year. It follows that the only generalization on secular variation the existing data are adequate to support is that if there was a trend toward larger head girth over the period from 1890 to 1945, the rate of rise was small and the total amount of increase too slight to be of practical significance for the pediatrician.

Racial differences in head circumference

Are there differences in head girth among North American infants of White, Negroid and Mongoloid ancestry? Do White infants of northwest European lineage differ in head girth from those of southeast European descent? Materials relating to these questions are decidedly limited.

For Mongoloid infants, a single study is available. Ito (17) has reported a mean head girth of 33.9 cm. on 202 neonates of Japanese ancestry born in California. The subjects were drawn mainly from the lower classes. When aligned with the composite mean for White infants from Table 9, and with the Bakwin and Bakwin mean for White infants of the lower and middle classes from Table 1, Ito's mean is found to be 0.4 cm. lower in each instance.[4] On further comparison with studies for White infants representing a "below average" socio-economic level (see Table 1), Ito's mean is identical with the Montague and Hollingworth mean from infants predominantly of southeast European ancestry and 1.1 cm. less than the Vickers and Stuart mean from infants predominantly of northwest European ancestry. The conclusion indicated is that the mean head circumference of American-born neonates of Japanese lineage is similar to that for neonates of southeast European stocks, but smaller than for those of northwest European stocks.

For Negro infants, there are two studies - both on males. A mean head girth at two years of age from a sample of four "southern Negro" (Georgia) males is accessible from Ramsay (24). Means at three months, one year, and two years have been published by Rhoads and others (25) on 99 "northern Negro" (Pennsylvania) males of "low socioeconomic level" fed a prescribed diet.[5] Table 11 places these studies in juxtaposition

[4]*Both differences are statistically significant at the 1 per cent level of confidence (t = 4.0 and 3.8).*

[5]*Evaporated milk with supplementary vitamins C and D from six weeks after birth, cereal added in the fourth month, puréed vegetables and fruits in the sixth month, meat and eggs in the ninth month.*

with composite means for White males (see Table 24), means for the White counterpart of the study by Rhoads and others, and means from the Vickers and Stuart study (34) on White males principally from the middle classes and of northwest European descent. While the Vickers and Stuart sample differs a little in socio-economic and ethnic composition from that of Rhoads and others, the two studies are similar for anthropometric technique and dietary of the subjects.

TABLE 11

HEAD CIRCUMFERENCE (Centimeters): Means for Negro male infants compared with selected means for White male infants.

Racial Group		3 mos.		12 mos.		24 mos.	
		Number	Mean	Number	Mean	Number	Mean
Ramsay (1953): Negro						4	48.7
Rhoads & others (1945):	Negro	99	39.8	99	46.2	99	48.5
	White	134	39.9	134	46.4	134	48.8
Vickers & Stuart (1943): White		125	40.8	113	47.1	102	49.6
Composite White (see Table 24)		724	40.4	1145	46.7	856	49.2

Examination of Table 11 shows the Negro means to be surpassed by the White means at all three ages. For the Negro and White counterparts of the study by Rhoads and others the differences are slight and not statistically significant. Differences appreciably larger, and statistically significant throughout,[6] accrue from comparison of the Negro series of Rhoads and others with each of the remaining White series.[7]

Can it be inferred that North American Negro and White infants, if drawn from similar socio-economic backgrounds and given the same health care, do not differ in head circumference? Or, does head girth tend to be smaller for the Negro infant than for the White infant? To reply to either of these questions affirmatively would be hazardous in the absence of further clarification and pending additional research. The questions require that the intended connotation of the words "White" and "Negro" be specified, thereby affording a clear frame of reference covering the amount of White admixture encompassed by

[6] *The t values lie between 4.0 and 5.9.*

[7] *In this connection it must not be overlooked that some systematic factor(s) may be operating in the study of Rhoads and others to yield both Negro and White samples which are atypically small for head circumference.*

"Negro" and the proportions of various White subgroups symbolized by "White." From the standpoint of research materials relating to the questions, it has been indicated above that the only substantial data presently available are those from one study for male infants of the lower classes - here, the White group is "in large proportion of northern European stock, with approximately one-fourth of Italian descent," while the Negro group includes infants with "any known trace of Negro blood" (25, pp. 416, 437). Head girth investigations for North American Negroes are lacking on newborn infants of both sexes, on females at all infancy ages, and on all but one socio-economic level.

For White infants predominantly or exclusively of northwest European ancestry, several studies are available. Except at birth, however, there are no materials on infants of southeast European lineage with which they may be compared. At birth, the only study known to be based predominantly on subjects of southeast European lineage is that of Montague and Hollingworth (23). These investigators obtained a mean of 33.9 cm. (see Table 1) on 2,000 infants of the lower to middle classes born in New York City. For comparison, the study by Vickers and Stuart (34) best satisfies the two-fold criterion of being similar in socio-economic selection and known to be based predominantly on subjects of northwest European descent. This study, utilizing 209 Boston neonates of the middle to lower classes, yielded a mean higher than that of Montague and Hollingworth by 1.1 cm. The difference is statistically significant ($t_{-} = 9.4$), allowing the inference that neonates of southeast European ancestry tend to be smaller in head circumference than neonates of northwest European ancestry.

Socio-economic differences in head circumference

What is the relationship between the head circumference of infants at birth and the socio-economic status of their parents? At older infancy ages, are offspring from the indigent and unskilled groups smaller in head girth than offspring from the managerial and professional classes? These questions are conveniently considered in the same order as stated.

At birth, studies known to be based on White infants representing a "below average" socio-economic level are those of Bakwin and Bakwin (1), Montague and Hollingworth (23), and Stebbins (27). Ethnically, the first study typifies "mixed White stocks"; the second, "mainly southeast European descent"; and the third, "mainly northwest European descent." Only in the case of subjects mainly of northwest European descent are there investigations - Bayley and Davis (5), Washburn and Red-

field (35) - representing an "above average" socio-economic level. Compared with the mean from Stebbins of 34.1 cm. for "lower classes" (see Table 1), the combined mean from these "above average" data is higher by 0.7 cm. The significance ratio is sufficiently large ($t = 3.0$) to allow the generalization that head girth at birth averages slightly more on offspring from the professional classes than on those from the laboring classes. It must not be overlooked that this generalization rests solely on data for White infants of northwest European lineage.

At ages from three months to two years, the only investigation representing a "low income status" is that of Rhoads and others (25) for males. It will be recalled that this investigation affords means at three months, one year, and two years on 134 White males "in large proportion of northern European stock." For comparison with this series of means, an attempt was made to assemble other series which would be comparable for age, sex, and ethnic selection but portray different socio-economic levels. The procedure was that of pooling acceptable male data by age and socio-economic level. To represent the middle classes data were combined from Bakwin and Bakwin (2), Gesell and Thompson (12), and Vickers and Stuart (34). Data from Bayley and Davis (5), Meredith (21), Richdorf (26), and Washburn and Redfield (35) were pooled as characterizing a somewhat higher level (middle-to-upper classes). The means on each socio-economic group are aligned in Table 12.

TABLE 12

HEAD CIRCUMFERENCE (Centimeters): Means for White males representing three socio-economic levels. For all categories the subjects are mainly of northwest European ancestry.

Age (mos.)	Lower Classes		Middle Classes		Middle-to-upper Classes	
	Number	Mean	Number	Mean	Number	Mean
3	134	39.9	222	40.6	228	40.7
12	134	46.4	192	46.9	326	46.9
24	134	48.8	102	49.6	250	49.4

Findings from this table are:

1. The male infants of the middle classes practically coincide in mean head girth with the male infants depicting a somewhat higher level. What differences occur are not consistent in direction and appear soundly appraised as negligible in size.

2. Compared with the means representing the middle and middle-to-upper classes, the means on male infants of the low-

er classes are consistently and appreciably lower. With specific reference to the samples drawn from the middle classes and the lower classes, the differences at successive ages yield t values of 4.9, 3.6, and 4.8.

Although Table 12 leads to the conclusion that infants at the upper end of the socio-economic continuum have a larger average head circumference than those at the lower end, it does not afford an estimate of the magnitude of the difference. To derive such an estimate would necessitate representative samples drawn exclusively from the indigent and the wealthy groups (i. e., from narrow terminal segments of the socio-economic distribution). In Table 12, the "lower" category comprises infants under continuous dietary supervision and the "middle-to-upper" category encompasses approximately half the entire continuum.

Head girth in relation to diet

Is there a positive association between rate of growth in head circumference and early inclusion in the dietary of supplementary vitamins and minerals? Does the head girth of infants enrolled in a program of pediatric guidance tend to exceed that of infants drawn without reference to adequacy of diet or of other aspects of health care?

Programs of systematic pediatric guidance may be classified as in-patient (controlled regimen) or out-patient (prescribed regimen). The studies by Blatt and Schapiro (6) and Boyd (7) fall in the former category. Included in the latter category are studies by Bakwin and Bakwin (2), Joslin and Helms (18), Rhoads and others (25), Richdorf (26), and Vickers and Stuart (34).

In the Blatt and Schapiro and the Boyd investigations, head girth records were obtained on 236 physically normal, White infants (3 per cent Negro) living under controlled conditions of housing and diet. The subjects were housed in hospitals at Chicago and Iowa City respectively, and were fed diets "designed to meet good standards of infant nutrition."[8] By combining the data from both investigations, it was possible to secure means at selected ages representing the "controlled intake studies" presently available. Table 13 presents these means and compares them with the composite means for White infants from Table 9.

Table 13 also carries parallel columns of means for "prescribed intake studies," and for studies where there was little

[8] *Within the Blatt and Schapiro series there was experimental variation in the quantities of vitamin B and minerals, within the Boyd series experimental variation in the amount of vitamin D.*

or no attempt to modify the extent to which parents voluntarily availed themselves of the community resources for nutritional and health guidance. The latter column was derived by merging the investigations of Bayley and Davis (5), Gesell and Thompson (12), Meredith (21), and Washburn and Redfield (35); the former represents a colligation of data from Bakwin and Bakwin (2), Richdorf (26), and Vickers and Stuart (34). In both instances the subjects may be characterized as White infants mainly of northwest European ancestry and from homes of average to superior socio-economic status.

TABLE 13

HEAD CIRCUMFERENCE (Centimeters): Means for White infants receiving two types of dietary supervision compared with means obtained without reference to dietary supervision.

Age (mos.)	Controlled Intake Studies		Composite (from Table 9)		Controlled Intake − Composite	Significance Ratio (t)
	Number	Mean	Number	Mean		
3	132	39.2	1239	39.9	- 0.7	5.1*
6	122	41.9	2193	43.0	- 1.1	8.4
12	73	44.9	2166	46.0	- 1.1	6.2
18	45	46.6	1611	47.6	- 1.0	4.4
	Prescribed Intake Studies		Diversity of Intake		Prescribed Intake − Diversity	
(Infants mainly of northwest European ancestry and middle to upper classes)						
3	521	40.1	371	40.2	- 0.1	...
6	508	43.0	561	43.2	- 0.2	...
12	354	46.3	676	46.2	0.1	...
24	206	48.9	471	48.8	0.1	...

*These ratios were calculated using the appropriate composite sigmas from the footnote to Table 10.

The first major finding from Table 13 is that mean head girth is decidedly smaller for infants participating in controlled intake investigations than for the conglomerate of White infants studied. This finding may be reinforced by noting in Tables 3 to 7 that no other head girth data on full-term infants collected since 1920 have yielded values for central tendency as low as those of Blatt and Schapiro (data collected 1931-33) and Boyd (data collected 1930-44). How is the relatively small head girth of these "controlled intake" subjects to be explained? Boyd's measurements were made "over the greatest prominence of the occiput and of the glabella"; Blatt and Schapiro did not specify the anthropometric landmarks employed. Boyd's infants

were "presumably normal," Blatt and Schapiro's were without "abnormalities of the head due to syphilis, rickets, hydrocephalus or microcephalus." For both studies, the subjects were well infants "living under as nearly ideal conditions as institutional life permitted." There remains the probability that factors negatively related to head size operated in the selection of the samples - the probability that infants available for in-patient research tend to be smaller in head girth than infants selected at random.

A second major finding from Table 13 is that, with particular reference to the middle and upper socio-economic groups, mean head girth is not significantly different on infants enrolled in a program of pediatric guidance than on infants less homogeneous for dietary and health care. At no age can the mean from the prescribed intake studies be regarded as dependably larger than that depicting the greater range of intake. The increase in mean over the interval from three months to two years is the same for the prescribed intake studies (8.0 cm.) as for the wide assortment of studies combined in Table 9.

Studies pertaining to the association between rate of growth in head circumference and early inclusion in the dietary of special vitamin and mineral supplements are those of Blatt and Schapiro (6), Joslin and Helms (18), and Rhoads and others (25). Blatt and Schapiro investigated the relationship of head girth in infancy to inclusion in the dietary of a cereal mixture especially enriched with vitamin B and minerals. The subjects were 136 well infants distributed in age over the first two postnatal years and "observed for periods varying from six weeks to one year." For those observed during early infancy, the basic diet included cow's milk with dextrimaltose, orange juice, and cod liver oil. Cereal was added at three months, vegetables and soups at five months, eggs and puddings in the ninth month. Sixty-six infants were fed "the commonly used cereals" and 70 the cereal mixture rich in minerals and vitamin B. No information was afforded on the numbers followed for six weeks only and for longer periods to one year. Head girth averages at eighteen months of age exceeded those at three months by 7.3 cm. for the experimental group and 7.4 cm. for the control group. Over the same age interval, the difference in the composite means from Table 9 is 7.7 cm.

Joslin and Helms' study also dealt with the association between gain in head circumference and "amount of vitamin B complex in the diet." Here, 100 infants were followed "over a period of one year" through a pediatric clinic. The basic diet consisted of milk, water and carbohydrate, with the addition of cereal and vegetables after six months of age. Half the group

was prescribed a special mixture of carbohydrate with vitamin B complex. The average gains in head girth were 9.8 cm. for the experimental series and 9.3 cm. for the control series. In the absence of evidence that the two series were equated for age or head size at the beginning of the study, it is not possible to evaluate their difference in gain. Moreover, since the specific limits of the one-year period(s) are not designated, no fruitful comparisons can be made with findings from other studies. It is improbable that the period covered was the first postnatal year - this follows from Table 9, where the difference between the composite means for White infants at birth and at one year is shown to be 11.7 cm. The figures reported by Joslin and Helms more nearly approximate the rise in the composite trend of 9.7 cm. between the ages of one and thirteen months.

Rhoads and others investigated the influence of supplements of vitamins D, A, and B complex on the head girth of 233 male infants under dietary supervision from an average age of six postnatal weeks until the end of the second year. Four dietary subgroups were formed. All were prescribed a basic diet which included evaporated milk and orange juice from the first examination; banana, cereal, and puréed vegetables and fruits by six months; and egg, meat and potatoes by one year. In addition, one subgroup each was supplied the following daily vitamin supplements: 110 U.S.P. units of D; 110 U.S.P. units of D and 2,250 units of A; 1,500 U.S.P. units of D and 15,000 units of A; 110 U.S.P. units of D, 2,225 units of A, 0.5 mg. of B_1 and 0.2 mg. of B_2. Analyses at ages three months, one year, and two years yielded no statistically significant differences in head circumference between any of the subgroups. For all four subgroups of White males combined, the mean at two years surpassed the mean at three months by 8.9 cm. Over the same period, the increase in composite means for White males without regard to diet (see Table 24) is 8.8 cm.

How may the foregoing studies on "head girth in relation to diet" be summarized? First, it must be recognized that they lie within a somewhat restricted nutritional zone. All of the groups compared probably typify nutritional standards between "mildly inadequate" and "optimum." Within this zone, the over-all finding is that no positive relationship between diet and head circumference has been demonstrated.

Head girth in relation to disease

There is a paucity of head circumference data on groups of infants hospitalized for ill-health, diagnosed as having a specific disease, or appraised as poorly nourished. Bakwin and

Bakwin (3) compared the head girths of 126 infants having "typical facial eczema" with those of 775 infants hospitalized either "as healthy boarders or because of mild respiratory infections." Both samples were composed of White infants of "low income" families. The records on the eczematous infants were plotted in relation to the mean trend for the non-eczematous infants - 60 per cent fell above the trend and 40 per cent below. It was implied that the tendency toward larger head circumference found among the eczematous infants indicated that "constitution is a factor in the etiology of eczema." Unfortunately, Bakwin and Bakwin's materials were not reported in a form which allows them to be quantitatively aligned with materials from other studies.

Chapin (9) and Fleischner (11) each studied head circumference on "hospital patients," many of whom were considered "much below par." Their samples were obtained at New York City - one in 1894 and the other around 1905. Table 14 places combined means at three ages from these studies in juxtaposition with composite means for like ages from Table 9. Also exhibited in Table 14 are averages representing two subdivisions of Fleischner's data. It will be recalled that this investigator classified approximately 40 per cent of his subjects as poorly nourished and 25 per cent as well nourished.

TABLE 14

HEAD CIRCUMFERENCE (Centimeters): Means from infants hospitalized for ill-health compared with means obtained without reference to health history. Subgroups of hospital patients considered poorly nourished and well nourished are also compared.

Age (mos.)	"Hospital patients" Number	"Hospital patients" Mean	Composite (from Table 9) Number	Composite (from Table 9) Mean	Hospitalized − Composite
3	102	37.9	1239	39.9	- 2.0
6	84	40.4	2193	43.0	- 2.6
9	88	42.5	1791	44.9	- 2.4
	"Poorly nourished"		"Well nourished"		Poorly Nourished − Well Nourished
3	...	36.2	...	40.1	- 3.9
6	...	39.2	...	42.6	- 3.4
9	...	41.2	...	44.4	- 3.2

Findings from Table 14 are:

1. Mean head girth is markedly smaller for the "hospital patients" than for the composite of North American infants. The range of disease conditions and physical defects encompas-

sed by "hospital patients" was not described by either Chapin or Fleischner. Chapin commented that many of his subjects were "much below par," Fleischner mentioned the "probability" that a number of his were born prematurely. Inspection of Tables 3, 4 and 5 will show Chapin's means to be the smallest listed and Fleischner's to rank next.

2. Mean head girth is markedly larger for the hospital patients rated as well nourished than for those rated as poorly nourished. Fleischner made reference to the probability that a "large majority" of the poorly nourished group was "premature." In this connection it is relevant to note that the sample of premature infants studied by Mohr and Bartelme (22) yielded a mean head circumference at age nine months over two centimeters higher than that from the infants Fleischner classed as "poorly nourished."

3. Mean head girth is no larger for Fleischner's "well nourished" class of hospital patients than for the composite of White infants used in deriving Table 9. For example, at age six months the mean on the infants appraised as well nourished is 42.6 cm., while that reproduced from Table 9 is 43.0 cm.

Head girth in relation to prematurity

Data for head circumference on infants born prematurely are available from Mohr and Bartelme (22) and from Talbot (31). In Talbot's study, "the criteria used in establishing prematurity were weight, stature, and general considerations, such as facies, texture of the skin, undeveloped nails, cry, unstable temperature and history of expected birth"; Mohr and Bartelme's criterion was "birth weight less than 2,500 gm." Talbot's subjects were considered "from four to ten weeks premature"; Mohr and Bartelme's had a mean gestation period of approximately thirty-four weeks. Talbot used statutory age; Mohr and Bartelme corrected statutory age for the estimated amount of prematurity. Talbot's data afford a mean one month after birth; Mohr and Bartelme's data supply means at older ages. Table 15 aligns both studies with comparable materials on full-term infants. (See Table 15, p. 45.)

It will be seen that:

1. At the end of the first postnatal month, the mean head girth of the premature infants studied by Talbot is 30.9 cm. (12.2 in.) - roughly equivalent to the mean head girth for normal fetuses one month prior to birth. The mean from Table 9 for North American full-term infants age one month is higher by 5.7 cm. (2.2 in.).

2. At the middle of the second postnatal year, the mean head girth of the premature infants followed by Mohr and Bartelme

TABLE 15

HEAD CIRCUMFERENCE (Centimeters): Comparison of central tendency values for premature and full-term infants.

Age	Infants Born Prematurely		Full-term Composite (from Table 9)		Prematurely Born - Full-term
	Number	Mean	Number	Mean	
1	13	30.9	195	36.6	- 5.7
3	6	37.1*	1239	39.9	- 2.8
6	10	42.0	2197	43.0	- 1.0
9	15	44.2	1791	44.9	- 0.7
12	16	45.9	2166	46.0	- 0.1
18	48	47.6	1611	47.6	0.0

*The means for premature infants at ages three to eighteen months represent statutory age minus the estimated amount of prematurity.

is practically equal to that for full-term infants. (Adjustment of the premature mean at eighteen months to statutory age would only reduce it from 47.9 cm. to 47.6 cm.). It will be recalled that Mohr and Bartelme's subjects were the recipients of excellent postnatal care.

The generalization which accrues is that the mean trends for head circumference on infants born "prematurely" and "at term" gradually converge during infancy. In relation to the trend for full-term infants, the trend for premature infants ascends from a lower level at birth to become almost superimposed by the middle of the second year.

Head girth in relation to birth molding and birth order

Anthropometrically comparable data for head circumference at birth are available from Calkins (8) and Tiber (32). Tiber's sample was drawn without reference to birth molding, while Calkin's sample represents heads largely free from molding, i. e., births by cesarean section or breech extraction. Both investigators measured the maximum perimeter of the head through the glabella, using "very slight uniform pressure." Their subjects were all full-term, viable infants, and the means obtained were, for Calkins, 35.2 cm. and, for Tiber, 33.5 cm. (see Table 1). Calkins' mean (N = 27) is 1.7 cm. higher than Tiber's, and 0.9 cm. higher than the composite mean from Table 9. The significance ratios from both comparisons allow the inference that full-term neonates have a smaller head circumference following the typical birth process than following cesarean section.

Bakwin and Bakwin (1) compared means for head girth derived from measurement of 812 first-born infants and 841 infants of later birth orders. Both series of data were accumulated by the same anthropometrist, utilizing White neonates delivered

at four New York City hospitals. The "later-born" sample gave a mean of 34.5 cm. A mean lower by 0.3 cm. was secured from the "first-born" records.

One other reference treating head circumference in relation to order of birth is that by Williams (36). Three decades prior to publication of the Bakwin and Bakwin study, Williams reported that mean head girth was "somewhat larger" for "children of multiparae than those of primiparae." While no quantitative material on different parity classes was supplied, the notation is consistent with Bakwin and Bakwin's finding of a slightly smaller mean girth for first-born neonates than for the aggregate of neonates of other birth orders.

Sex differences in head girth

Answers were sought to the following questions: What is the average head circumference of males and females at selected infancy ages? Is the head circumference of the typical newborn male larger than that of the female? Does the difference between the sexes increase or decrease during infancy? How widely dispersed are the measurements of head girth for male and female infants at different ages? Does variability change appreciably over the first two postnatal years? Do the records of head girth for one sex show greater scatter than those for the other?

The method employed was that of first compiling Tables 16 to 23. These tables bring together all of the available central tendency and variability values for full-term male and female infants at each of eleven ages - the same eleven ages as were used in constructing Tables 1 to 8. The tables are self-explanatory.

The next step consisted of utilizing Tables 16 to 23 to derive an over-all representation at successive ages of the central tendency and variability materials on White infants of each sex. Except for rejections on either of two counts (to exclude non-White data or to avoid duplicate use of White data), all of the figures assembled for a given age and sex were employed. The specific rejections were as follows: From Table 16, Stuart (1934), Ito (1936) and Holt and Howland (1919); from Table 18, Stuart (1934) and the Negro data of Rhoads and others (1945); from Tables 19 and 22, Stuart (1934) and Holt (1897); from Table 20, Stuart (1934); from Table 21, Stuart (1934), the Negro data of Rhoads and others (1945) and Holt (1897); from Table 23, Stuart (1934), the Negro data of Rhoads and others (1945), Ramsay (1853) and Holt (1897).

TABLE 16

HEAD CIRCUMFERENCE AT BIRTH (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from thirteen North American studies. See Table 1 for a list of the leading characteristics of each sample.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stebbins (1933)	50	34.6	1.0	2.9	32.6	33.3	34.0	35.1	35.9	37.3
Stuart (1934)	50	35.4	1.3	3.7	32.4	33.7	34.5	36.0	37.3	38.0
Vickers and Stuart (1941)	99	35.3	1.2	3.4	32.6	33.5	34.4	36.2	37.0	38.0
Montague and Hollingworth (1914)	1000	34.2	1.7	4.9	29.0		33.1	35.2		41.5
Taylor (1919)	125	34.7	1.6	4.2	29.8		34.2	35.3		37.8
Ito (1936)	94	34.0	1.1	3.3	31.6					37.5
Bayley and Davis (1935)	28	35.5	1.1	3.2	33.5					39.0
Calkins (1922)	18	35.2			33.0					37.5
Washburn and Redfield (1945)	9	31.7			33.0					36.6
Tiber (1930)	106	33.8					32.7	34.8		
Bakwin and Bakwin (1934)	818	34.6	1.3	3.7						
Holt (1897)	231	35.5								
Holt and Howland (1919)	...	35.3								
Females										
Stebbins (1933)	50	33.6	1.0	2.8	31.4	32.4	32.9	34.4	34.9	35.2
Stuart (1934)	63	34.4	1.4	4.1	31.2	33.1	33.7	35.5	36.0	37.0
Vickers and Stuart (1941)	110	34.7	1.0	2.9	31.0	33.4	33.9	35.4	36.0	37.2
Montague and Hollingworth (1914)	1000	33.6	1.6	4.6	28.0		32.6	34.7		39.5
Taylor (1919)	125	34.1	1.2	3.6	30.6		33.4	34.8		36.8
Ito (1936)	108	33.8	1.2	3.7	28.0					37.0
Bayley and Davis (1935)	25	34.5	1.4	4.0	31.3					37.0
Calkins (1922)	9	35.1			33.4					38.5
Washburn and Redfield (1945)	13	34.0			32.4					35.9
Tiber (1930)	102	33.1					32.3	34.0		
Bakwin and Bakwin (1934)	835	34.0	1.3	3.7						
Holt (1897)	215	34.5								
Holt and Howland (1919)	...	34.3								

TABLE 17

HEAD CIRCUMFERENCE AT AGES ONE WEEK TO TWO MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from thirteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
ONE WEEK: Males										
Richdorf (1925)	20	35.0	1.1	3.2	32.8		34.0	36.0		37.5
Tiber (1930)	106	34.4					33.4	35.3		
Stebbins (1933)	50	35.0	1.0	2.9	31.1	33.5	34.4	35.5	36.4	37.4
Females										
Richdorf (1925)	21	34.4	0.8	2.3	32.5		34.0	35.0		35.5
Tiber (1930)	102	33.6					32.8	34.5		
Swanson (1926)	30	33.9								
Stebbins (1933)	50	34.0	1.0	2.9	31.8	32.8	33.2	34.7	35.2	35.6
TWO WEEKS: Males										
Stuart (1934)	33	36.3	1.2	3.3	33.9	35.0	35.5	37.0	37.9	38.2
Bakwin and Bakwin (1936)	c.90	35.4	1.5	4.1						
Females										
Stuart (1934)	50	35.5	1.2	3.4	32.8	33.7	34.6	36.5	37.2	38.0
Bakwin and Bakwin (1936)	c.100	34.8	1.4	4.0						
ONE MONTH: Males										
Washburn and Redfield (1945)	20	37.2	1.3	3.6	34.6		36.5	37.9		39.3
Bayley and Davis (1935)	24	38.6	1.2	3.1						
Boyd (1945)	55	36.0	1.4	3.9						
Grover (1915)	4	36.7								
Iowa Child Welfare Research Station (1931)	14	37.5								
Females										
Washburn and Redfield (1945)	20	36.4	1.0	2.7	34.0		36.0	36.9		38.1
Bayley and Davis (1935)	26	37.1	1.2	3.3						
Boyd (1945)	16	35.0	0.8	2.3						
Grover (1915)	3	35.6								
Iowa Child Welfare Research Station (1931)	13	35.1								
TWO MONTHS: Males										
Meredith (1944)	35	38.9	1.1	2.8	36.3		38.2	39.7		41.0
Washburn and Redfield (1945)	19	38.8	1.2	3.0	36.2		38.2	39.6		40.8
Gesell and Thompson (1938)	14	39.0	1.2	3.2	36.2					40.6
Iowa Child Welfare Research Station (1931)	22	39.3	1.4	3.5						
Bayley and Davis (1935)	31	40.1	1.1	2.8						
Boyd (1945)	65	38.4	1.4	3.8						
Females										
Meredith (1944)	25	38.2	1.3	3.5	35.6		37.3	39.0		40.5
Washburn and Redfield (1945)	22	37.8	0.8	2.0	36.0		37.3	38.4		39.2
Gesell and Thompson (1938)	12	38.1	1.0	2.6	36.5					39.5
Bayley and Davis (1935)	27	38.8	1.2	3.1						
Boyd (1945)	17	37.2	1.3	3.4						
Iowa Child Welfare Research Station (1931)	6	37.6								

TABLE 18

HEAD CIRCUMFERENCE AT AGE THREE MONTHS (Centimeters). Central tendency and variability values for full-term male and female infants. The values are drawn from fourteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	[illegible]	[illegible]	1.1	2.5	39.6	39.2	40.1	41.8	42.7	44.0
Vickers and Stuart (1943)	125	40.[illegible]	1.2	2.9	39.2	39.2	40.0	41.5	42.1	44.5
Meredith (1944)	112	40.6	1.1	2.6	37.9	39.2	40.0	41.2	41.8	41.6
Richtorf (1925)	50	41.[illegible]	1.5	3.[illegible]	37.0		39.4	41.[illegible]		44.0
Washburn and Pritchard (1935)	35	41.4	1.2	2.9	35.8		39.7	41.3		42.6
Gesell and Thompson (1938)	12	40.0	0.7	2.3	39.1					42.3
Baldwin, Fillmore and Bailey (1930)	17	41.[illegible]	2.3	5.[illegible]						
Iowa Child Welfare Research Station (1931)	37	40.[illegible]	1.4	3.4						
Bayley and Davis (1935)	31	41.5	1.2	2.9						
Bakwin and Bakwin (1960)	[illegible]	40.2	1.3	3.3						
Boyd (1945)	71	41.[illegible]	1.4	3.5						
Woods and others (1938)										
White	138	39.[illegible]	1.3	3.2						
Negro	[illegible]	40.0	1.3	3.3						
Grover (1914)	2	40.6								
Talbot (1921)	[illegible]	41.4								
Females										
Stuart (1934)	68	39.2	1.2	3.[illegible]	38.2	37.5	38.1	41.1	41.8	42.6
Vickers and Stuart (1943)	121	40.0	1.3	3.[illegible]	37.0	36.5	39.2	40.9	41.7	42.8
Meredith (1944)	93	39.8	1.2	3.1	36.4	37.9	39.2	40.2	41.0	42.1
Richtorf (1925)	50	40.1	1.2	2.9	37.0		39.3	40.9		41.3
Washburn and Pritchard (1935)	40	41.3	1.0	2.4	37.1		39.7	40.0		41.2
Gesell and Thompson (1938)	13	39.4	1.1	2.7	37.5					40.9
Baldwin, Fillmore and Bailey (1930)	12	39.8	2.1	5.3						
Bayley and Davis (1935)	29	40.2	1.1	2.6						
Bakwin and Bakwin (1960)	[illegible]	39.2	1.3	3.4						
Boyd (1945)	36	40.5	1.2	3.1						
Grover (1915)	9	37.7								
Talbot (1921)	[illegible]	39.4								
Iowa Child Welfare Research Station (1931)	9	39.3								

TABLE 19

HEAD CIRCUMFERENCE AT AGE SIX MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from eighteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	45	44.2*	1.1	2.4	41.8	42.5	43.3	45.0	45.7	46.0
Vickers and Stuart (1943)	117	44.0	1.0	2.3	41.8	42.7	43.3	44.8	45.4	46.3
Meredith (1944)	205	43.7	1.3	2.9	40.4	42.2	42.9	44.5	45.4	47.2
Richdorf (1925)	50	43.5	1.0	2.3	41.5		42.9	44.2		45.9
Washburn and Redfield (1945)	42	43.4	1.2	2.7	41.0		42.6	44.2		46.3
Gesell and Thompson (1938)	15	43.8	0.9	2.0	42.4					45.4
Iowa Child Welfare Research Station (1931)	40	44.3	1.6	3.7						
Bayley and Davis (1935)	30	44.9	1.2	2.6						
Bakwin and Bakwin (1936)	c. 75	43.2	1.2	2.7						
Boyd (1945)	64	42.4	1.2	2.7						
Holt (1897)	...	43.5								
Grover (1915)	14	42.5								
Crum (1916)	259	44.1								
Holt and Howland (1919)	c.100	43.2								
Talbot (1924)	25	42.6								
Baldwin, Fillmore and Hadley (1930)	23	44.1								
Mohr and Bartelme (1934)	5	42.0								
Females										
Stuart (1934)	57	43.1	1.3	3.0	41.0	41.4	42.1	43.9	44.8	46.2
Vickers and Stuart (1943)	131	42.9	1.2	2.8	40.2	41.4	42.0	43.6	44.5	46.8
Meredith (1944)	180	42.4	1.3	3.0	38.8	40.8	41.6	43.2	44.0	45.2
Richdorf (1925)	50	42.3	1.3	3.2	39.2		41.5	42.9		44.8
Washburn and Redfield (1945)	41	42.4	1.0	2.4	39.0		41.7	43.9		44.4
Gesell and Thompson (1938)	19	42.2	1.0	2.4	40.4					44.8
Iowa Child Welfare Research Station (1931)	19	42.7	1.6	3.8						
Bayley and Davis (1935)	28	43.3	1.2	2.7						
Bakwin and Bakwin (1936)	c.85	42.1	1.2	2.8						
Boyd (1945)	13	41.2	0.8	1.9						
Holt (1897)	...	42.2								
Grover (1915)	11	41.5								
Crum (1916)	176	42.9								
Holt and Howland (1919)	c.100	42.3								
Talbot (1924)	25	42.1								
Swanson (1926)	30	40.8								
Baldwin, Fillmore and Hadley (1930)	19	42.2								

*The mean is reported as 44.9, the median as 44.2. There is apparently a typographical error in the case of the mean.

TABLE 20

HEAD CIRCUMFERENCE AT AGE NINE MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from thirteen North American studies. See Table 5 for a list of the leading characteristics of each sample.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	41	46.0	1.1	2.4	43.6	44.4	45.1	46.7	47.4	48.4
Vickers and Stuart (1943)	115	45.8	1.0	2.2	43.1	44.5	45.1	46.5	47.1	49.0
Meredith (1944)	249	45.6	1.2	2.7	42.6	44.1	44.7	46.4	47.2	49.2
Richtorf (1925)	49	45.4	1.2	2.6	43.0		44.6	46.2		49.0
Washburn and Redfield (1945)	38	45.3	1.0	2.2	43.0		44.7	46.1		47.1
Gesell and Thompson (1938)	17	45.9	1.2	2.5	43.9					48.6
Baldwin, Fillmore and Hadley (1930)	41	46.0	1.6	3.5						
Iowa Child Welfare Research Station (1931)	32	45.2	1.3	2.8						
Bayley and Davis (1935)	27	47.0	1.2	2.5						
Bakwin and Bakwin (1936)	c.20	45.2	1.3	2.9						
Boyd (1945)	24	44.3	1.1	2.5						
Crum (1916)	211	45.8								
Females										
Stuart (1934)	54	44.8	1.4	3.1	42.3	42.9	43.8	45.8	46.8	47.9
Vickers and Stuart (1943)	121	44.7	1.2	2.7	43.1	43.2	43.8	45.4	46.3	47.9
Meredith (1944)	226	44.2	1.2	2.7	41.1	42.8	43.1	45.0	45.8	47.2
Richtorf (1925)	49	44.2	1.4	3.1	42.1		43.9	45.5		48.3
Washburn and Redfield (1945)	30	44.2	1.2	2.7	41.3		43.5	45.1		46.5
Gesell and Thompson (1938)	17	43.9	1.2	2.8	42.2					46.5
Baldwin, Fillmore and Hadley (1930)	26	44.2	1.9	4.3						
Iowa Child Welfare Research Station (1931)	24	44.5	1.5	3.3						
Bayley and Davis (1935)	29	45.4	1.1	2.9						
Bakwin and Bakwin (1936)	c.20	44.1	1.2	2.7						
Crum (1916)	183	44.7								
Mohr and Bartelme (1934)	4	44.3								
Boyd (1945)	4	42.7								

TABLE 21

HEAD CIRCUMFERENCE AT AGE ONE YEAR (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from sixteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	37	47.2	1.0	2.1	45.1	45.6	46.5	47.9	48.6	49.3
Vickers and Stuart (1943)	113	47.1	1.1	2.3	43.4	45.5	46.5	47.8	48.4	49.3
Meredith (1944)	258	46.8	1.3	2.8	43.6	45.1	45.9	47.6	48.5	50.3
Washburn and Redfield (1945)	40	46.6	1.0	2.2	44.2		46.0	47.3		49.2
Gesell and Thompson (1938)	19	47.3	0.9	1.8	45.4					48.5
Baldwin, Fillmore and Hadley (1930)	33	46.9	1.3	2.8						
Iowa Child Welfare Research Station (1931)	26	47.1	1.5	3.2						
Bayley and Davis (1935)	28	48.5	1.3	2.7						
Bakwin and Bakwin (1936)	c.60	46.5	1.3	2.8						
Boyd (1945)	24	45.5	1.2	2.6						
Rhoads and others (1945):										
White	134	46.4	1.3	2.7						
Negro	99	46.2	1.5	3.2						
Holt (1897)	...	45.9								
Grover (1915)	11	44.6								
Crum (1916)	284	47.1								
Holt and Howland (1919)	c.100	45.7								
Talbot (1924)	15	46.8								
Females										
Stuart (1934)	48	46.0	1.4	3.0	43.6	44.1	44.9	46.9	47.9	49.1
Vickers and Stuart (1943)	121	45.9	1.3	2.8	43.2	44.3	45.0	46.7	47.7	49.1
Meredith (1944)	238	45.4	1.3	2.8	42.3	43.8	44.4	46.3	47.2	48.5
Washburn and Redfield (1945)	42	45.5	1.2	2.7	42.4		44.6	46.4		48.0
Gesell and Thompson (1938)	24	45.0	1.1	2.4	43.3					47.9
Baldwin, Fillmore and Hadley (1930)	23	45.4	2.1	4.7						
Iowa Child Welfare Research Station (1931)	25	45.5	1.2	2.6						
Bayley and Davis (1935)	27	46.8	1.4	2.9						
Bakwin and Bakwin (1936)	c.60	45.5	1.1	2.4						
Holt (1897)	...	44.6								
Grover (1915)	12	44.9								
Crum (1916)	228	45.9								
Holt and Howland (1919)	c.100	44.5								
Talbot (1924)	25	46.0								
Boyd (1945)	4	44.9								

TABLE 22

HEAD CIRCUMFERENCE AT AGE EIGHTEEN MONTHS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from fourteen North American studies.

Investigator	N	Mean	S.D.	V	Minimum	Percentiles 10	25	75	90	Maximum
Males										
Stuart (1934)	34	49.1	1.2	2.4	47.0	47.4	48.1	49.8	50.9	51.2
Vickers and Stuart (1943)	109	48.8	1.1	2.3	46.2	47.3	48.0	49.4	50.1	51.8
Meredith (1944)	264	48.3	1.2	2.5	45.8	46.7	47.5	49.1	49.9	51.7
Washburn and Redfield (1945)	41	48.3	0.8	1.7	45.9		47.9	48.9		50.0
Baldwin, Fillmore and Hadley (1930)	32	48.4	1.3	2.8						
Iowa Child Welfare Research Station (1931)	23	48.8	1.3	2.6						
Bayley and Davis (1935)	22	47.8	1.3	2.8						
Holt (1897)	...	47.1								
Grover (1915)	14	46.9								
Crum (1916)	181	48.4								
Holt and Howland (1919)	c.100	47.5								
Talbot (1924)	15	48.5								
Mohr and Bartelme (1934)	4	48.3								
Females										
Stuart (1934)	44	47.4	1.4	3.0	44.8	45.7	46.4	48.3	49.5	50.1
Vickers and Stuart (1943)	102	47.4	1.2	2.5	43.9	45.8	46.5	48.3	49.1	50.2
Meredith (1944)	294	47.0	1.3	2.6	43.9	45.3	46.0	47.8	48.6	49.6
Washburn and Redfield (1945)	39	47.0	1.4	3.1	43.4		46.1	48.0		49.8
Baldwin, Fillmore and Hadley (1930)	21	46.8	1.8	3.8						
Bayley and Davis (1935)	23	48.0	1.3	2.7						
Holt (1897)	...	45.9								
Grover (1915)	7	45.6								
Crum (1916)	178	47.1								
Holt and Howland (1919)	c.100	45.7								
Talbot (1924)	15	47.8								
Swanson (1926)	30	46.0								
Iowa Child Welfare Research Station (1931)	13	47.4								
Mohr and Bartelme (1934)	8	46.2								

TABLE 23

HEAD CIRCUMFERENCE AT AGE TWO YEARS (Centimeters): Central tendency and variability values for full-term male and female infants. The values are drawn from fifteen North American studies.

Investigator	N	Mean	S.D.	V	Mini-mum	Percentiles 10	25	75	90	Maxi-mum
Males										
Stuart (1934)	26	50.0	1.3	2.6	47.8	48.2	49.1	50.9	51.7	52.0
Vickers and Stuart (1943)	102	49.6	1.2	2.4	46.0	48.1	48.7	50.4	51.2	52.0
Meredith (1944)	186	49.3	1.2	2.4	46.7	47.9	48.4	50.2	50.9	52.3
Washburn and Redfield (1945)	40	49.3	0.9	1.8	47.6		48.7	49.9		50.9
Baldwin, Fillmore and Hadley (1930)	25	49.4	1.3	2.7						
Iowa Child Welfare Research Station (1931)	17	50.0	1.1	2.3						
Bayley and Davis (1935)	24	50.7	1.4	2.8						
Rhoads and others (1945):										
White	134	48.8	1.3	2.7						
Negro	99	48.5	1.5	3.1						
Ramsay (1853)	4	48.7								
Holt (1897)	...	48.1								
Grover (1915)	14	48.2								
Crum (1916)	201	49.3								
Holt and Howland (1919)	c.100	48.7								
Talbot (1924)	10	49.2								
Mohr and Bartelme (1934)	3	50.3								
Females										
Stuart (1934)	30	48.2	1.3	2.7	46.2	46.5	47.2	49.2	50.0	50.5
Vickers and Stuart (1943)	104	48.2	1.4	2.9	45.5	46.3	47.1	49.1	50.2	51.4
Meredith (1944)	165	48.0	1.2	2.5	45.0	46.4	47.1	48.9	49.6	51.0
Washburn and Redfield (1945)	38	47.9	1.4	3.0	44.2		47.0	49.1		50.5
Baldwin, Fillmore and Hadley (1930)	20	47.9	1.1	2.3						
Iowa Child Welfare Research Station (1931)	23	48.2	1.3	2.7						
Bayley and Davis (1935)	18	49.0	1.2	2.4						
Holt (1897)	...	47.2								
Grover (1915)	9	48.3								
Crum (1916)	160	48.2								
Holt and Howland (1919)	c.100	47.5								
Talbot (1924)	10	48.8								

The synthesis derived is presented in Table 24. The upper portion of this table affords composite means,[9] standard deviations,[10] and coefficients of variation[11] for full-term White infants of each sex. In the lower portion of the table are additional columns portraying the composite range, the typical range, the typical distance between the tenth and ninetieth percentiles, and the typical interquartile distance (seventy-fifth percentile minus twenty-fifth percentile). There is the statistical distinction between the "composite" and the "typical" values. To illustrate, The composite standard deviation for males at birth is the standard deviation of one distribution formed by "combining" the distributions from several studies: The typical interquartile distance for males at birth is the mean obtained by "averaging" the interquartile values from several studies. Similarly, the "composite range" for newborn males is the difference between the minimum and maximum records reported, while the "typical range" is the mean of the range values from different studies.

Findings from Table 24 (i.e., sex differences for North American White infants born at term) are:

1. Male infants exceed female infants in mean head girth at all ages from birth to two years. The difference increases over the period from birth to six months, and remains practically constant during the succeeding eighteen months. In magnitude, the difference approximates one-fourth inch (0.6 cm.) at birth and one-half inch (1.2 cm.) between six months and the end of the second year.

2. At birth, mean head girth is 34.5 cm. (13.6 in.) for male

[9] *For an algebraic statement of the formula used, see footnote 3.*

[10] *The formula for calculating a composite standard deviation is*

$$S.D._c = \sqrt{\frac{N_1(S.D._1^2 + d_1^2) + N_2(S.D._2^2 + d_2^2) + \ldots + N_x(S.D._x^2 + d_x^2)}{N_1 + N_2 + \ldots + N_x}}$$

in which S.D. symbolizes standard deviation, N symbolizes number of measures, d represents the deviation of the mean of a component sample from the mean for the composite sample, subscript c designates the composite sample, and the numerical subscripts designate component samples.

[11] *Computed by the usual formula (V = S.D. x 100/Mean), using composite values in the numerator and the denominator.*

TABLE 24

HEAD CIRCUMFERENCE (Centimeters): Central tendency and variability values for White Infants of each sex studied in North America during the period 1890-1945. (See text for a description of the basic materials and the methods of integration.)

Age (mos.)	Composite Means				Composite Measures of Variability					
	MALES		FEMALES		MALES			FEMALES		
	N	Mean	N	Mean	N	S.D.	V	N	S.D.	V
Birth	2484	34.5	2483	33.9	2320	1.5	4.3	2305	1.5	4.4
1	117	36.9	78	36.1	90	1.6	4.3	62	1.4	3.9
2	186	39.0	109	38.1	186	1.4	3.6	104	1.3	3.4
3	724	40.4	496	39.4	697	1.4	3.4	464	1.3	3.3
6	1064	43.7	927	42.5	638	1.3	3.0	566	1.3	3.1
9	863	45.6	702	44.5	652	1.3	2.9	501	1.3	3.0
12	1145	46.7	929	45.5	735	1.3	2.8	560	1.4	3.0
18	744	48.3	745	46.9	439	1.2	2.6	394	1.3	2.8
24	856	49.2	647	48.0	528	1.3	2.6	369	1.3	2.7

	"Typical" Measures of Variability						Composite Range	
	75th Percentile - 25th Percentile		90th Percentile - 10th Percentile		Maximum - Minimum		Maximum - Minimum	
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES
Birth	1.6	1.6	3.0	2.6	6.3	6.0	12.5	11.5
3	1.6	1.5	2.8	3.1	5.3	4.7	7.5	6.5
6	1.5	1.5	3.0	3.1	4.8	5.5	6.8	8.0
9	1.5	1.6	2.9	3.0	5.5	5.6	6.6	7.4
12	1.4	1.8	3.2	3.4	5.2	5.6	6.9	6.8
18	1.3	1.8	3.0	3.3	5.2	6.1	6.0	6.9
24	1.6	2.0	3.1	3.5	5.0	6.0	6.3	7.2

infants and 33.9 cm. (13.3 in.) for female infants. Expressed in relation to these birth values, the means at two years are higher by 14.7 cm. (5.8 in.), or 42.6 per cent, for males and 14.1 cm. (5.6 in.), or 41.6 per cent, for females. The smaller increases for females reflect the divergence of the sexes during the first six months. The means at six months surpass those at birth by 9.2 cm. (26.7 per cent) and 8.6 cm. (25.4 per cent) on males and females respectively: In contrast, the means at two years exceed those at six months by 5.5 cm. (12.6 per cent) on males and 5.5 cm. (12.9 per cent) on females.

3. At all ages between birth and two years, the composite standard deviations for male and female infants are similar. Identical values on both sexes are shown at birth, six months, nine months, and two years. Of the twelve standard deviations representing ages above two months, all except three - two on males and one on females - have the same magnitude (1.3 cm.). The larger values at birth (1.5 cm.) accrue primarily from inclusion of the Montague and Hollingworth study (see Table 16). It is the writer's view that the standard deviations from this

study are probably spuriously high due to the unreliability of the measurements.[12]

4. Over the first two postnatal years, there is a continuous decrease in the relative variability of head girth. Inspection of the "V" columns in Table 24 shows this finding to hold for both sexes. On the assumption that the "true" standard deviations are 1.3 cm. at birth and at all later ages to two years, the coefficients of variation decrease from a birth value of 3.8 per cent for each sex to the obtained values at two years of 2.6 per cent and 2.7 per cent for males and females respectively.

5. For each sex at birth, the typical interquartile distance is 1.6 cm. (0.6 in.). This figure may be taken as characteristic of the entire series of values for both sexes at all ages - the fluctuations are between 0.3 cm. below to 0.4 cm. above. An alternative estimate of the interquartile distance may be derived via the standard deviation. On the assumption that the head girth is normally distributed, the middle fifty per cent of the measurements lie clustered within a zone equal to 1.35 S. D. Taking the S. D. at 1.3 cm., the estimated interquartile distance is 1.8 cm. (0.7 in.).

Generalizing, it appears that for male or female infants of any age between birth and two years the zone circumscribing the central one-half of the head girth distribution extends from one-third inch below the mean to one-third inch above the mean.

6. The typical distance between the tenth and ninetieth percentiles may be considered to approximate 3.1 cm. (1.2 in.). Values at specific ages vary from 2.6 cm. to 3.5 cm., with 3.0 cm. and 3.1 cm. predominating. The distance between the tenth and ninetieth percentiles of a normal probability distribution having a standard deviation of 1.3 cm. is 3.3 cm. (1.3 in.). It follows that at any age during infancy about 10 per cent of male head girths lie 1.6 cm. or more above the male mean and 10 per cent of female head girths 1.6 cm. or more above the female mean. Correspondingly, there are around one-tenth of the infants of each sex with head girths no less than 1.6 cm. - two-thirds inch - below the mean for their age and sex.

7. Over the age period from three months to two years, the values for the typical range fluctuate around 5.4 cm. (2.1 in.) and those for the composite range around 6.9 cm. (2.7 in.). The

[12] *In this connection, compare the investigations of Montague and Hollingworth (23) and Bakwin and Bakwin (1). The latter was based on records made by a trained anthropometrist, the former on routine hospital records; the latter obtained standard deviations of 1.3 cm. on each sex, the former of 1.7 cm. on males and 1.6 on females; both used large, heterogeneous samples. See Also Reference 20, p. 46.*

values at birth register the exceptionally wide dispersion of the Montague and Hollingworth data (see Table 16) and are regarded as spuriously high. The question arises: Why is the "composite range" greater than the "typical range"? The difference is due, at least in part, to the fact that the composite range is obtained from a larger sample of infants than is any value used in deriving the typical range. It may also be due in part to the composite range encompassing variations in the anthropometric technique with which different portions of the pooled data were secured.

Specific for any infancy age and for nonpathologic White infants of either sex, a working approximation of the "true" range of the head girth distribution may be taken as 6.4 cm. - as extending from a minimum one and one-fourth inches below the mean to a maximum one and one-fourth inches above the mean.

SUMMARY

This paper constitutes Part I of a bipartite study dealing with head circumference during the first two years of postnatal life. It presents a review and synthesis of North American research to date on groups of infants. Its companion paper will colligate the studies made in North America pertaining to the growth of individuals.

Source materials are drawn from thirty-five investigations - twenty-nine published over the years 1853-1945 and six not previously reported in published form. These materials are integrated with reference to the information they afford on ten problems. That is, intercomparisons are made and generalizations derived on head girth in relation to age, sex, lineage, socio-economic status, secular period, diet, disease, prematurity, birth molding, and birth order.

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FATHER-FANTASIES AND FATHER-TYPING IN FATHER-SEPARATED CHILDREN

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The average American father differs considerably from the classical stereotype of a punishment-threatening, tyrant-giant as depicted in European psychoanalytic theory. Still the local U. S. culture is largely patriarchal and paternal opinions are still decisive in the settling of most major family issues. Although the frequently absent father may relegate to the more often present mother the majority of actual punishment executions, and coming home from work, he may be "seldom in a mood to institute disciplinary measures" (13, p. 259), his children (above the age of three and one-half years) are, nevertheless, accurately aware of the preferential power position that the father has in the family.[2]

The psychological nature of a child's relationship to his father is, therefore, of great consequence to the child's present security and later outlook. It is not surprising that complications in this relationship are found in the history of many individuals with adjustment difficulties and that clinical studies of young adults have shown that respect and affection for the father is more characteristic for satisfactory home adjustment than the presence of sentiments of respect and affection for the mother (13).

These impressions gained in clinical practice warrant our research interests in theories and facts concerning father-child relationships.

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[2]*This inference is based on observations made by the author during experiments with preschool children whose play fantasies projected distinctly different emotional reactions to teacher-doll stimulations, depending on the power status that the dolls were given, e.g., assistant teacher, regular, and head teacher.*

The kind of emotional experiences that a son or daughter has within the dynamics of the father-child relationship are given much emphasis in practical mental hygiene (6), and in systematic clinical theories (7). Nevertheless, non-speculative, empirical studies of this relationship have been primarily sociological in nature, relating, for example, the intelligence or attitude test scores of children to the occupational, educational or political status of their fathers (cf. 9).

The present research trend seems to be away from such "ecological" studies (11) as more analytical approaches to the parent-child relationship become popular. Several investigators have attempted to investigate the emotional aspects of this relationship (e.g., 13). However, most of these concentrate on maternal influences (10, 21), or the father and mother are considered as one "parental unit" (2). Much useful information concerning the father has come incidentally out of these studies, but more specific investigations of the intimate, emotional aspects of father-child contact are needed. The present paper reports a research effort in this direction.

Methodology

Subjects

The conditions of war, generally so destructive to systematic research, provided in this case an opportunity for an investigation of the emotional reactions of children to prolonged separation from the father. The enlistment of mature men with families made it possible to locate in Cleveland, Ohio an experimental group of twenty normally adjusted school children, equally divided as to sex, ages six to ten, of average intelligence, and lower middle-class, urban background, whose fathers had been with the Armed Forces abroad from one to three years, and who were still away at the time of the investigation in the Spring of 1945.

A control group of children matched for age, sex, intelligence, school and home background, was also available. The fathers of the control children were deferred from military service and were living with their families. School and home background and overt manifestations of the parent-child relationship were ascertained by intensive interviews of mothers and teachers. These interviews followed the methodology of the Fels Research Group (2, 3, 4).

The Doll Play Technique

The children's emotional reactions to separation from the father were studied by means of a standardized projective doll

play technique which was developed by the author from recent experiments conducted by Sears and his associates at Iowa (1, 14, 15, 16).

The doll play experiments took place in a special room in each of the two elementary schools attended by the subjects.[3]

Each child subject was introduced to the experimenter by the teacher. On three occasions, separated by two to four days, the experimenter took the child from the classroom to the experimental room for a twenty-minute play session. The entire experimental routine, including the experimenter-child relationship before, during and after the three play sessions, was standardized according to a detailed Manual of Instructions. This manual was prepared by the writer in cooperation with Gloria Bremer, who acted as co-experimenter. The essential features of this procedure are summarized below.

Play Materials

The child was presented with a semi-realistic roofless doll house having the dimensions of 22" x 28". This doll house simulated in stream-lined form a five-room, middle-class family home. There was a living room, dining room, kitchen, bathroom, two bedrooms, a hall and a large closet. Most of the stream-lined furniture was glued to the floor to inhibit manipulative construction play and to encourage play with the dolls proper, thus stimulating social fantasies.

Four dolls, a father, a mother, and two children, a boy and a girl, were available to the child. All subjects were given the same family constellation. The parent dolls were 5" and the child dolls 3" tall. The dolls had a realistic appearance and could easily be made to assume any desired posture.

Initial Instigation of Fantasy

After a brief explanation of the physical facilities of the doll house, the experimenter invited the child to make up a story or play. The experimenter made it clear that it could be any kind of a story; that the child could make the four "people in this home" act in any way he wanted them to.

After the experimenter gave these instructions, he began the recording of the fantasy responses. After twenty minutes the recording was discontinued and the play session terminated.

All of the children in this study entered the task with interest, and while activating the dolls, they verbally reported what the dolls did, how they felt, etc.

The Subject-Experimenter Relationship

Once the experimenter felt that the subject had understood and accepted the task, his role was that of a very friendly, sympathetic, interested, but non-interfering, non-suggesting, listener, onlooker and recorder of the child's story. The experimenter unobtrusively recorded without loss of rapport-contact with the child. No attempt was made to conceal from the subject the scoring work or to deny its connection with his play. The experimenter, upon being questioned, would explain to the child, "I like to collect stories; I like your story."

The experimenter never suggested any theme or fantasy actions to the child even when the child did attempt to get play suggestions from him. Such questions for fantasy support were turned back to the subject by such comments as, "It is your

[3]*The author gratefully acknowledges the generous cooperation received from Jane Armbruster of the Paul Revere Center, and from Adela Losch of the Miles School, Cleveland, Ohio.*

story; it is your play; it is up to you what to make it; it can be anything you want it to; you know how to do it"; etc.

The experimenter made a few standardized comments designed to reduce anxiety or inhibition, or to stimulate expressiveness, and to terminate the session in a way meaningful to the child. For example, whenever for purposes of more reliable recording, the meaning of a doll play fantasy could be clarified by a fuller degree of expression of the child's fantasy, the child was encouraged to be more expressive either verbally or manipulatively with such comments as, "Show me what they do," or "Make them act it out," or "Tell me what they are doing." This stimulation of expression was used only on the rare occasions when it became necessary for the understanding of the meaning or direction of the doll actions. But in all cases of any type of stimulation, suggestions of fantasy content were avoided.

In this way the requirement of assuring the same instigating condition for the projective father fantasies of both the experimental and the control groups was thought to be fulfilled. Yet the standardization of the S - E relationship did not interfere with maintenance of a rapport which made the child feel: "Here is a sympathetic, friendly, non-teacher-like, non-authoritative adult with whom I can be free and spontaneous and who likes me and my stories."

Record Taking

The experimenter took a running account of the play fantasies during the three sessions as the subject produced them. He classified the fantasy content into a few pre-defined categories by means of symbols which were entered on a record sheet. After some experience and practice, it was possible to record doll actions and experiences separately for each of the four characters of the doll drama. These doll actions and experiences were the child's fantasies and constituted the recording units. A scoring symbol stood for a single unit of thematic action for a doll character during a fifteen-second interval as indicated by an electric timer (buzzer).[4]

When two or more doll characters were active in any doll-doll interaction, as many symbols denoting the nature of the action were recorded as dolls were involved and the direction of the social interaction between the dolls was indicated by means of arrows. In this way every doll action was recorded under one of the fantasy categories previously defined in the manual.

This system of recording had a degree of reliability of 89.81 per cent average agreement for all categories between the two experimenters who shared in the collection of these data. This estimate of reliability was obtained on twelve pre-experimental doll play sessions with one of the experimenters taking turns scoring the same subjects from behind a one-way vision screen, while the other experimenter recorded while working with the child.

Major Doll Play Fantasies

All doll play fantasies were immediately classified by the experimenter into various categories. The fantasy categories of particular relevance to the present study are given below.

Stereotype Fantasies: Dramatizations of dolls which in content simulate habitual routine actions and experiences that could ordinarily be expected (on the basis of stereotypes of "home" and family life) to be performed by real persons in an analogous actual setting. Stereotyped doll actions and experiences are like photographic reproductions of commonly appropriate, "proper," non-individualistic, social behavior (e.g., polite greetings, sitting down to eat dinner, to listen to the radio, going to bed, using the toilet properly, etc.).

Fantasy Aggression: The child made the doll act or described the doll as acting or intending to act injurious, punishing, disparaging, or depreciative towards another doll, or the child described the doll character as being in an aggressive attitude, nature, manner, or mood, etc.

Aggressive fantasies were subdivided according to the social direction of these

[4] *Thanks go to David Roberts of Western Reserve University for constructing two very reliable timing instruments.*

aggressions, and their severity, e.g., killing was a sub-category of fantasy aggression. Other subdivisions included justification of hostile aggressions, defensive rationalization, aggression in response to commands in the nature of a retort or insubordination.

Fantasy Affection: The doll's actions denoted praise, reward, affection, friendliness, helpfulness towards other characters or enjoyment of another character's company.

Authoritative Fantasies: Included doll-doll interactions of an imperative, directive, ordering, or commanding nature.

Submissive Fantasies: Obliging and submissive doll actions in response to aggressive and/or directive instigation on the part of the other doll characters.

Other categories included such fantasies as Escaping, Chasing, Depressed, and Elated Moods, Sexual Investigation, and Repetitiveness.

Non-Thematic Behavior Categories

In addition to the subject's thematic productions, the experimenters paid close attention to and recorded the idiosyncrasies of the subject's behavior in the experimental situation other than his fantasies proper. Various types of non-thematic behavior were defined, tallied, and ratings of the emotional involvement and degree of inhibitions were made.

The reliability of some of these non-thematic data was found to be too low to be usable here. Individual differences between the investigators with respect to judgments and insights were apparently involved in some of those clinically important observations.

Analysis

The records obtained by the procedure briefly outlined above furnished detailed information of the quality of projective fantasies concerned with inter-personal family relationships. They permitted tabulation and statistical analyses without any post-experimental ratings or classifications.

In so far as the hypothesis that fantasy responses are projective is justified (17), the data present in effect an inventory of the child's actual emotional adjustment to his own family.

Since it was the purpose of this study to see whether this adjustment was influenced by prolonged separation from the father, the data were analyzed to yield a comparison between the father fantasies of the experimental (father-separated) group with the father-fantasies of the control (father-home) group. It was thought that knowing in detail the way father-separated children elaborated about the father in their fantasies would yield some clues as to the psychogenetic importance of the father in the personality development of the child. Consequently, the statistical comparison between the two groups was limited to those fantasies in which the father character was involved.[5]

[5] *In the statistical analysis of the data the author received substantial help from Lorain Hite, graduate student at Kent State University.*

TABLE 1

Mean Frequencies of Projective Fantasies During Three Twenty-Minute Sessions of Doll Play

Fantasy Categories	Experimental Father Absent Av.	SD	Control Father Home Av.	SD	Diff.	t	l.o.c.
	N=20		N=20				
1. Total Number of Doll Actions of Any Kind	433.85	104.41	461.57	84.78	27.72	0.797	N.S.
2. Total Number of Doll Actions Involving Fa.	92.80	27.30	113.01	25.17	-20.21	2.129	<5%
3. Percent of Doll Actions Involving Fa.	22.49	5.52	25.27	3.37	-2.78	3.601	<1%

Results: Father Fantasies

The first group of the results of this comparison is given in Table 1. As can be seen, the experimental (father-separated) and the control (father-home) group produced about the same total amount of projective doll play fantasies concerned with family life (Table 1, line 1). There was a slight, but nevertheless significant, preponderance of total number of fantasies involving the father character in the control group (lines 2 and 3). This difference was due to the fact that some of the father-separated children tended to leave the father out of the family scene more often, thus simulating the actual state of affairs in their own homes. This was to be expected on the basis of previous results reported on younger children by Bach (1, pp. 25-26), who estimated that 75 per cent of the normal preschool child's doll play fantasies are rather faithful reproductions of reality conditions.

It would, however, seem misleading to interpret this statistical difference to mean that on the whole the father-separated children left the father out of their fantasies of family life. On the contrary, as Table 1, line 3 shows, one should stress the fact that in spite of actual prolonged absence of the father from the home, the experimental group did include the father in 22 per cent of their fantasies as compared with 25 per cent, the usual chance elaboration of one out of the set of four dolls. The control group indeed showed this 25 per cent. Thus, when strong emotionally conditioned drives find their expression in fantasy, the percentage of reproductive, reality-simulating fantasies is lowered. This was found to be the case also in the school fantasies of the strongly frustrated group of children studied by

Bach (1).

However, the fact that the difference between the experimental and the control groups with respect to total amount of father fantasies was significant would have made it statistically misleading to compare absolute amounts of the father fantasy categories between the two groups, and necessitated the translation of the raw figures into percents using the total number of father fantasies as the base line. In other words, the results were analyzed for differences in the relative distribution of the specific types of father fantasies, since one group (the control) had a greater total of all father fantasies regardless of specific type. The results of this analysis are shown in Table 2 and Figure 1.

Among the sixteen comparisons that were made, eleven statistically significant differences between the father fantasies of the two groups were found. The starred lines in Table 2 and the bars in Figure 1 show the eleven categories of father fantasy that significantly differentiated the father-separated from the father-home children. The experimental (father-separated) group is represented in the figure by the solid black bars.

TABLE 2: EFFECTS OF SEPARATION

Mean Percent-Frequency of Occurrence of Father-Fantasy Categories During Three Twenty-Minute Sessions of Doll Play

All Doll Play Fantasy Categories that Involved the Father	Experimental N=20 Mean %	SD	Control N=20 Mean %	SD	Diff. between means	t	l.o.c.
1* Stereotype Family Life	67.61	11.16	52.97	16.53	+14.64	4.000	< 1%
2 Aggression received by Fa.	5.11	3.10	8.04	3.10	- 2.93	1.230	>20%
3† Aggression from Fa.	4.83	7.14	15.26	6.61	-10.30	3.495	< 1%
4* Affection received by Fa.	6.64	5.26	3.32	3.24	+ 3.32	2.030	< 5%
5 Affection given by Fa.	3.27	3.63	4.65	2.24	- 1.38	1.103	>20%
6* Directions by Fa.	2.06	2.06	4.37	3.23	- 2.29	2.409	< 3%
7 Directions received by Fa.	2.14	0.52	3.82	3.53	- 1.68	0.840	>20%
8 Escape from Fa.	0.38	3.44	1.80	1.23	- 1.75	1.278	>20%
9* Fa. in Depressed Mood	0.00	0.00	1.56	1.06	- 1.56	6.677	< 1%
10 Fa. in Elated Mood	4.58	6.69	2.29	2.20	+ 2.29	0.969	>20%
11* Unclassified, Individual.	3.84	5.14	2.01	2.78	+ 1.83	2.173	< 4%
More Specific Fantasies Included in the Above							
12* Social Recreations (Stereo.)	19.69	7.70	8.28	7.25	+11.41	4.134	< 1%
13* Fa's. Aggr. ag. Children	4.54	6.56	14.76	7.86	-10.41	3.980	< 1%
14* Mo's. Aggr. ag. Fa.	1.29	2.57	4.06	4.80	- 2.77	2.144	< 4%
15* All Fantasy Aggressions Involving Fa. (2,3,6)	9.69	11.90	24.87	8.60	-14.98	12.525	< 1%
16* Fa. Affection for Children	7.91	5.76	4.08	2.89	+ 3.83	2.174	< 4%

The experimental group has a preponderance of stereotyped fantasies about family life (Table 2, line 1). More specifically (line 12), the father-separated children elaborated more intensively the leisure time living room recreational activities of

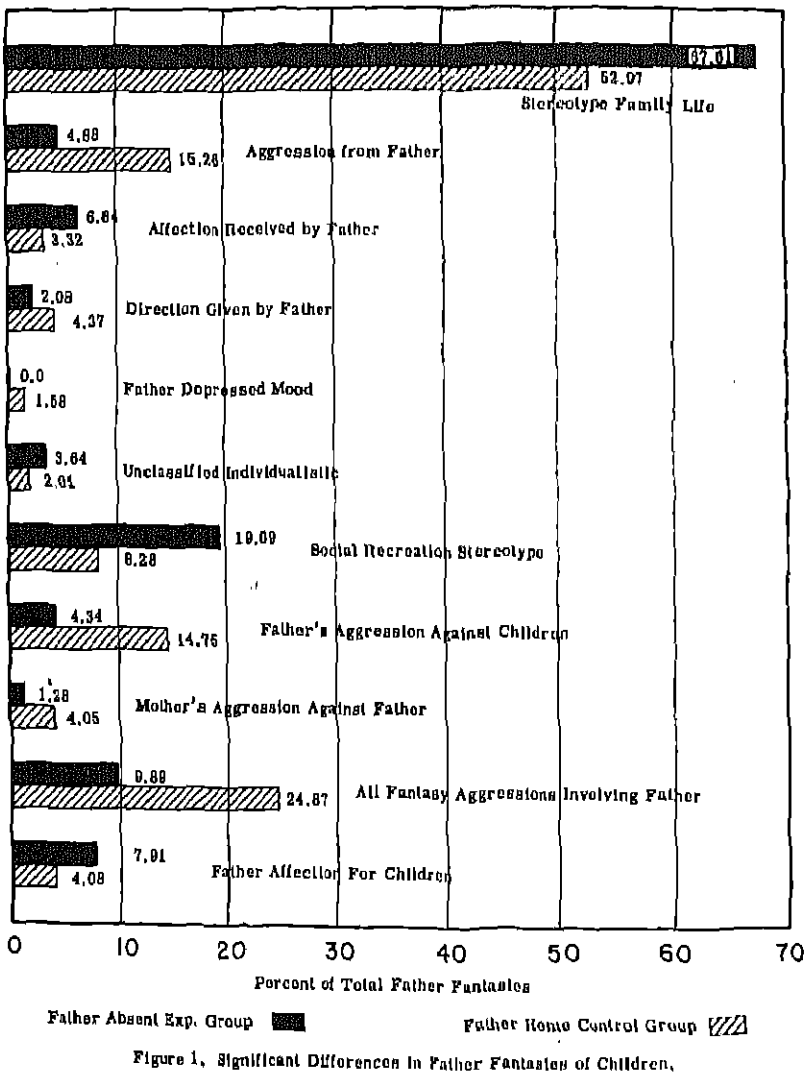

Figure 1. Significant Differences in Father Fantasies of Children.

the family. In these fantasies the father was shown to enjoy sitting with the children and listening to the mother play the piano, or just sitting and reading the paper while the children amused themselves in the living room, etc.

Very significant were the differences found in fantasy aggression. The proportion of the father's aggressive behavior toward both the family as a whole (line 3) and the children in particular (line 13) is less in the fantasies of the father-separated children. The father is also less often the recipient of the mother's hostility (line 14), and no child in the experimental group represented the father as being in a depressive or angry mood at any time (line 9). In general, the father-separated children had relatively fewer aggressive fantasies that involved the father than did the control children (line 15).

The results on the fantasy aggressions of the school age child are similar to Sears' recent finding of reduced fantasy aggression in preschool boys who were separated from their fathers during the war (19).

With respect to affectionate fantasies, it was found that the father-separated group pictured the father as giving more affection to his children (line 16), as well as receiving more affection from his family (line 4).

The experimental group also produced fewer authoritative fantasies that showed the father in a demanding and authoritarian role (line 7).

In summary, father-separated children produce an idealistic fantasy picture of the father, who has a good time with his family and who is enjoyed by them. He gives and receives much affection and has little marital discord. This fantasy-father shows very little hostility and does not exert his authority. The children of the control group, however, living as they do in daily contact with their fathers, elaborate significantly more upon the punitive function of the father and his contribution to intra-family hostility.

In so far as these differences are the result of prolonged separation, they seem to indicate the existence of strong drives for paternal affection, and for a harmoniously functioning father-mother relationship. Why would the child, whose doll play fantasies tend to be simulations of reality, otherwise include the actually absent father in such a large proportion of his thematic production? And since Bach (1) has previously shown that stereotyped-idealistic and repetitive doll play fantasies tend to be diagnostic (projective) of strong positive wishes, the existence of a strong drive for the possession of a loving and generous father is evident from the present data. However, since the fantasies of the experimental children are very similar to

the stereotyped, non-aggressive fantasies found in girls living under ordinary family conditions (1, 16), the pronounced differences between the experimental and the control groups may reflect to some extent the increase in amount and extent of maternal-feminine social stimulation. The theoretical implications of these results are discussed in more detail later, but there is no question about the fact that the projective doll play technique is a rather sensitive indicator of psychological changes brought about by changes in the social environment of the child (1).

Further Results: Sex Differences

The reader will have noticed that the major results of this study were reported for the two groups as a whole without reference to sex differences. This was made possible by the initial equalization of the number and the psycho-sociological characteristics of the boys and girls in the two groups studied. Although the major interest of the writer is in the question of the effect of father-separation on children in general, it is interesting to ask the question whether boys and girls differ in their reaction to this separation factor.

Table 3 presents the results of a comparison made between the father fantasies of the father-separated boys and the father fantasies of the father-separated girls.

TABLE 3: SEX DIFFERENCES

Comparison of Mean Percent-Frequency of Occurrence of Father-Fantasy Categories Between Father-Separated Boys and Girls

All Doll Play Fantasy Categories that Involved the Father	Boys N=10 Mean %	SD	Girls N=10 Mean %	SD	Diff. between means	t	l.o.c.
1* Stereotype Family Life	82.72	13.30	71.64	11.00	- 0.92	0.429	< 1%
2* Aggression received by Fa.	8.41	7.74	1.00	2.45	+ 6.61	0.210	< 1%
3* Aggression from Fa.	7.72	8.70	2.04	2.91	+ 6.08	5.004	< 1%
4* Affection received by Fa.	4.60	4.65	8.60	4.70	- 3.92	3.868	< 1%
5 Affection given by Fa.	7.32	6.05	8.49	4.33	- 1.17	1.080	>20%
6 Directions by Fa.	2.09	2.09	2.21	1.94	- 0.12	0.170	>20%
7 Directions received by Fa.	2.03	2.67	2.26	1.99	- 0.23	0.322	>20%
8 Escape from Fa.	0.45	0.71	0.32	0.65	+ 0.13	0.336	>20%
9 Fa. in Depressed Mood	0.00	--	0.00	--	0.00	---	-
10* Fa. in Elated Mood	8.34	5.04	3.85	6.16	+ 4.49	3.938	< 1%
11* Unclassified, Individual,	5.00	6.17	2.28	3.33	+ 2.72	2.856	< 2%
Sub-Categories Included in the Above							
12 Social Recreations (Stereo.)	18.02	9.43	20.47	5.04	- 1.86	1.225	> 20%
13* Fa's. Aggr. ag. Children	6.44	6.30	1.84	2.85	+ 4.60	3.773	< 1%
14 Mo's. Aggr. ag. Fa.	1.67	3.30	0.09	1.45	+ 0.78	1.112	> 20%
15* All Fantasy Aggressions Involving Fa.	10.14	13.07	3.85	4.81	+12.29	2.523	< 1%
16 Fa's. Affection for Children	3.15	4.02	3.39	3.16	- 0.19	0.215	>20%
17 % of Fa.-Fantasies of all Doll Play Fantasies	23.20	5.45	21.74	5.31	+ 1.52	1.393	>20%

As was expected on the basis of previous studies (1, 16), appreciable sex differences were observed. The nature of these differences is consistent with the previously reported results on younger children: the boys showed a significantly greater amount of aggressive fantasies (Table 3, lines 2, 3, 15) and the girls exceeded in affectionate fantasies (lines 4, 10) and in stereotype (line 1).

Since it seems that these sex differences are general and apparently a rather stable personality factor related to cultural sex-typing (1, 16), it would be misleading to emphasize that the father-separated girl makes the father in her fantasy even less aggressive and more affectionate than does the boy, because one would expect this without the separation factor on the basis of the known sex differences in projective doll play fantasies. Rather, it is possible that school-age children of either sex are about equally affected by father-separation. This is an interesting conjecture, however, which fortunately is receiving further experimental attention (cf. 19).

Further Results: Father-Typing

In order to determine whether stimulus variables in the immediate social environment of the child during the separation period influenced the pronounced idealistic fantasies found in these children, some follow-up analyses within the experimental group were made.

The data gathered in the home interviews included information about maternal "father-typing." Father-typing is a dispositional concept that denotes the general personality characterizations of the father that mothers (or other persons close to the child) give to the child, e.g., "Your father is strong"; "Your father is strict"; "Your father is a hard and mean man"; "Your father is a kind and generous man"; etc.

As was mentioned previously, the mothers of all the children were interviewed. At least two two-hour home visits were made to each of the families, and the instructions for home interviews that H. Champney devised (3, 4) were followed in a modified form. Among the modifications used was an original interview schedule, part of which was designed to record data concerning father-typing. A copy of one of the data sheets on father-typing that was used in these interviews is shown on page 74.

In addition to this direct type of evidence of father-typing, the interviewers rated the father's pre-war behavior on the Fels-Scales on the basis of mothers' reports. This somewhat unorthodox procedure provided an additional opportunity to

SAMPLE-PAGE OF ORIGINAL INTERVIEW SCHEDULE

I. "Father-Typing." How is the father presented to the child by the mother? What kind of a person is he made out to be? Extent to which he is being "used" to motivate child's behavior during his absence.

A. Father is described to S or discussed in presence of S in the ways indicated by the ratings below. (In cases of families where none of these father-typing-ratings fit, describe on back of this sheet.)

F idol; over-imitated	F worthy appreciated	F taken for granted	F critical; imitation reproved	F image taboo
F prestige high; income, profession, reputation, achievements	prestige at neighborhood mean	Father's social prestige status low: (disapprovingly stressed)		
Father cornucopia from whom all blessings flow	F above standard	F adequate provider	F minimal provider	F "loafer" security comes from mother or others
F entire life devoted to family; misses loved ones if absent	F unselfish without self-abnegation	Unemotional acceptance; compromises self-interest	Shuns family responsibility; fled to army, or to lodge and bars	Complete disinterest rejection
F over aggressive, a bully	Father a leader in full control of any situation	F ambivalent variable or neutral	F gentle character, hates army, avoids conflicts.	F submissive imposed upon, "sissy" at work or in army

B. Anecdotes elaborating the above rating data:

assess maternal attitudes towards the absent father. The interviewer's and the teacher's descriptions of how the children's mothers talked about their absent husbands also gave valuable clues on father-typing, e.g., a typical correlate of unambiguously unfavorable father-typing was a mother's open expression of her contempt of her husband by warning her child "not to be like your father." All these data were used to select the cases in which by all indications the father-typing was unambiguously unfavorable.

Four cases, two boys and two girls, were located where the mothers described the absent father in only depreciative or critical terms, without any positive or favorable comments. In these cases it was felt safe to assume that the children heard only "bad things" about their absent father. There were more cases with some negative father-typing but only in these four was the father-typing devoid of any positive, compensatory

features whatsoever.

In our search for a contrasting group, we again found only two boys and two girls where it was safe to infer from the various interview data that their mothers provided the children with unambiguously favorable, perhaps idealistic father-typing, i.e., these children heard the absent father spoken of in affectionate, appreciative value terms only, and the child was praised whenever his behavior reminded the mother of her husband.

This procedure of selection was somewhat subjective, but since this is a first empirical investigation of father-typing, we had to be content with the poor degree of refinement achieved in this pilot study. The clinical and systematic importance of the possibility that mere verbal symbolization may have social substitute value, warranted the relatively extensive labor considering the few cases.

TABLE 41 FATHER-TYPING

Mean Percent-Frequency of Occurrence of Father-Fantasy Categories During Three Twenty-Minute Periods of Doll Play: Experimental Sub-Groups Only

Fantasy Categories	Fa-Typing Unfavorable N=4 Mean	SD	Fa-Typing Favorable N=4 Mean	SD	Diff. between means	t	l.c.c.
1. Aggression by Fa.	8.40	8.37	1.82	1.10	+6.58	3.691	>2%
2. Fa. Aggr. ag. Chil.	7.86	8.00	1.34	1.33	+6.64	3.651	>2%
3. Affec. Given to Fa.	9.31	5.26	1.63	1.89	+7.68	5.820	>1%

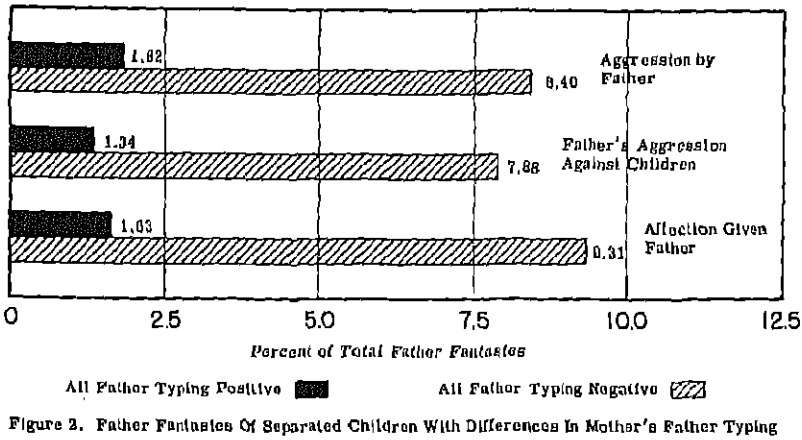

Figure 2. Father Fantasies Of Separated Children With Differences In Mother's Father Typing

Table 4 and Figure 2 show the three statistically significant differences that were found when the two subgroups (father-typing-unfavorable versus father-typing-favorable) were compared along the eleven fantasy categories which had significantly differentiated the experimental group as a whole from the control group. The discovery of these differences is evidence that the nature of the father fantasies that characterized the father-separated children was, in fact, influenced in certain respects by the father-typing variable.

The fantasies of the children with unfavorable father-typing (striped bars in Figure 2) picture the father to be relatively more aggressive, particularly against his children (Table 4, lines 1, 2). At the same time he receives more affection from them (line 3).

Further inspection and study of our father-typing data corroborated the statistically significant finding of curiously ambivalent aggressive-affectionate father fantasies in cases where the maternal father-typing tended to be depreciative.

These results force our attention to the further study of verbal father-typing and mother-typing as a stimulus-variable which in itself can modify the child's emotional relationship to his parents, even though the "typing" may be merely a more or less truthful expression of the degree of marital harmony or discord that exists in the family.

Furthermore, since father-typing is relatively easily controllable, full knowledge of this variable may be of practical value in prophylactic parent-education, in psychotherapy, and in the control of the personality development of children who have lost one or both parents.

Theoretical Considerations

Of systematic interest is the fact that the obtained data make theoretical sense when interpreted in the light of the frustration-aggression hypothesis (5), and the principles of social learning (12).

The biological dependency of the child and the patriarchal characteristics of American society provide the basis for the child's secondary drive for security and affection from the father, particularly strong in the so-called "latent period" in which identification with the father is an important support for the child's social habit acquisition (conscience learning).

While the father is accessible to the child, this drive is, on various occasions, readily reduced, but at other times it is severely frustrated through: 1) the exercise of paternal authority and 2) the fear of rivalry. This interference instigates ag-

gressive motivations, the goal-response to which would be actual hostility toward the father. This overt aggression is, however, at least partially blocked by the anticipation of retaliation, and, therefore, finds a substitute expression in aggressive fantasies (1).

When the father is absent, the drive for affection, security, and companionship has no opportunity to be reduced, and the absence of the father prevents father-instigated interference and the occasion for rivalry. Consequently, there is less instigation for aggressive fantasies, and the severly deprivated drive for paternal affection provides strong instigation for the idealistic, wish-fulfilling fantasies.

The mother as a social stimulus complicates this stimulus-response sequence. She may, through her father-typing, if favorable, further intensify the child's drive for the affection of his father, or, if unfavorable, she may interfere with this drive, perhaps by instigating fear of the return of the "nasty" father, in which case a conflict situation is created that instigates ambivalent, aggressive-affectionate father-fantasies.

This is undoubtedly not the only influence that the mother exerts on the child as a result of father-absence. As a matter of fact, the effectiveness of maternal stimulation, as indicated by the results on father-typing, suggests an alternate explanation of the major results in terms of social learning principles (12). Beyond influencing the child through father-typing, the mother may actually modify the child's personality development in the direction of femininity during the period of father-absence. The father is not available for imitation of or identification with masculine social behavior, and there is now more opportunity to imitate the feminine attitudes, manners, and values of the mother (cf. 20, pp. 153-154). The idealistic father-fantasies of both the separated boys and the separated girls with their stereotyped, affectionate and non-aggressive themes are very similar to the doll play fantasies characteristically produced by girls (in contrast to boys) under ordinary family conditions (1, 16). This "feminization" of the father-separated child's fantasy may then be a reflection of the increased potency of the mother as a social stimulus. The idealistic father-fantasies may, therefore, not only be an expression of the child's wish for an affectionate father but may actually also be symptomatic of a personality reorganization produced by exclusive maternal domination. If this interpretation is a valid one, the results of this study assume some significance with respect to the dynamics of cultural "sex-typing." However, further research into these relationships is required before an empirical evaluation can be made of the differential effects on personality

development of the various stimulus variables that come into play because of father-separation.

Practical Implications

At the time of this writing, problems of family readjustment after war experiences are of acute interest (8). The results of the present investigation suggest some insights of practical value pertaining to these problems.

The stereotyped, idealistic fantasy picture that the child has of the absent father may initially be a handicap in the re-establishment of a realistic father-child relationship. The child may experience a certain degree of disappointment over the wished for reunion. The father's resumption of domination and authority would certainly come in conflict with the child's idealistic expectations. Consequently, the instigation of feelings of paternal rejection is a strong possibility. The father can be expected to be puzzled by this and may develop the impression that his child has become estranged from him. This may lead to some disturbance of the morale of the family group.

But these unfortunate consequences of the child's way of having previously adjusted to separation will most likely be a temporary episode in the readjustment to reality, and the possibility of a seriously ineffective adjustment to the situation can be avoided by explaining to the returning father and to the mother the nature of the psychological forces at work in their child's mind.

Therapeutic Implications

The fundamental question of the effect of fantasy experiences on the development of overt behavior characteristics deserves a brief comment. It is a reasonable hypothesis based on observed effects of play therapy (18) that fantasy expressions have behavior modification potentialities similar to gratifying and painful reality experiences.

This can be so by virtue of the cathartic and/or anxiety characteristics of the fantasy response. These characteristics, together with the imitations and identifications noticeable in children engaged in doll play fantasies, should provide sufficient conditions for at least vicarious social learning.

To be sure, these behavior processes still need patient and careful empirical clarification, but such research effort seems justified by the indication that many of the factors that influence a child's fantasy also influence his actual personality development. Consequently, fantasy control can become one of our

most practical tools in our efforts to control personality development. The technical complications involved in the study and instigation of children's fantasies should not deter from this all-important possibility.

SUMMARY

The father fantasies of twenty father-separated children six to ten years of age and those of twenty control, father-home children, are compared by means of a standardized doll play technique. The father-separated children produced an idealistic and feminine fantasy picture of the father when compared with the control children, who elaborated the father's aggressive tendencies. The nature of the maternal father-typing seemed to influence this difference. Practical, clinical and theoretical implications of these results are discussed.

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BIOLOGICAL AND MEDICAL STUDIES AT THE SAMUEL S. FELS RESEARCH INSTITUTE[1]

L. W. SONTAG, M.D.

The Fels Research Institute was established in 1929 by Mr. Samuel S. Fels as an expression of his interest in people and the factors which constitute human effectiveness. It has undertaken a developmental study of structure, function and behavior in relation to environment and heredity. Because adult man is the product of innumerable environmental influences and their impact from conception to maturity upon inherited germ plasm characteristics, the Fels program was designed to permit the study of individuals throughout this age range.

As the Institute was initiated in 1929, it had a staff of three people. As techniques and methods were developed and data collected, the Institute grew. Its staff in 1941 consisted of twenty-five persons including assistants. Originally financed personally by Mr. Fels, in 1935 the Institute was taken over by the Samuel S. Fels Fund of Philadelphia. In 1945 the Institute which had completed its original term of existence, was placed on a continuing basis with an expanded budget and staff. A completely new research building providing greatly increased space and excellent equipment is now to be constructed.

The Institute is studying approximately three hundred white children and their families, who live in neighboring communities. Participation in the study is voluntary and participants are unselected, except that preference is given to families showing a reasonable prospect of permanent residence in this region.

Included in the disciplines represented on the Institute's staff are: medicine, anthropology, psychology, genetics, biochemistry, biology, and psycholphysiology. We are, of course, studying the whole child. That good but somewhat hackneyed term often leaves in the minds of an audience rather amorphous concepts of what really constitutes "whole child" research, beyond describing individual children in terms of every readily measurable characteristic from height to appetite. While such multidiscipline and longitudinal description of the whole child is valuable in itself, perhaps it is more important to use such data to answer questions about the nature, mechanics and predictability of individual differences in human beings.

I have selected from our Fels studies certain projects which

[1] *Paper presented at a general meeting of the Society for Research in Child Development in St. Louis, Mo., March 29, 1946.*

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will illustrate what we are attempting to accomplish. One of the studies I shall describe is that of the genetics of individual growth patterns of height and weight. Group growth curves are, of course, an average of a number of individual curves. Only occasionally does the curve of any individual child conform closely to the group pattern. (Slide I.) Instead he is likely to arrive at his end points of growth by means of one or more periods of rapid and slow growth, the temporal spacing of which is a highly individual characteristic. These and other interesting growth characteristics which children exhibit are often not readily explainable, either in terms of early or late sexual maturation or because of environmental factors, such as illness or nutrition. Children often change their body types insofar as height-weight relationship goes, at least once during the first ten years of life, and may reverse themselves twice or more.

Slide II shows the patterns of growth of a pair of monozygotic twins. The likeness of these curves is obvious and the periods of slow and rapid growth correspond very closely.

Slide III shows the growth curves of a pair of siblings, both of whom undergo violent periods of deceleration and acceleration in height, appearing at approximately the same period of life and who have also very similar changes in weight curves.

In order to study familial patterns, it is important to compare the similarities between identical twins, siblings and unrelated children. We have material for such studies of the characteristics of growth progress, because in our group the majority of families have more than one child and some have as many as seven siblings, all of whom have been observed since birth at the Fels Research Institute. Our work to date in this area suggests that aside from severe, prolonged malnutrition or illness, children tend to follow a predetermined growth curve which is resistant to minor differences in nutrition and the usual diseases of childhood. In other words, we believe that inheritance plays a large part in determining at what periods of a child's life he grows rapidly and at what periods he grows slowly in various body dimensions, ossification, teeth and other things.

One of our biochemical interests is an attempt to measure, if possible, the biochemical-physiological characteristics of constitution which, inherited or acquired, may determine or be correlated with the nature of such growth curves as I have shown previously. In other words, we hope to determine some of the physiological-biochemical characteristics of periods of slow growth and rapid growth and to learn which are inherited.

Annual or semi-annual determinations of the excretions of sex hormones and other ketosteroids, blood enzyme levels,

blood vitamin levels, vitamin load tests and other measures of this type constitute an important part of our research program and are the materials now available from which to attempt to fashion an understanding of the mechanics and significance of differences in the growth process.

A few of the many uses to which we are putting our biochemical data are studies of:

1. The normal ranges of blood enzyme levels.
2. Age changes in ketosteroid excretion levels.
3. Growth correlates of vitamin status.
4. Relation of ketosteroid excretion to body type.

All of us who have been studying individual differences in children have been frustrated by our inability to measure adequately individual differences in the biochemical functioning of human beings. This failure has severely limited our attempts to find the origin of such differences in structure and behavior.

Longitudinal biochemical studies of children are expensive. Furthermore, adequately accurate methods for measuring many important factors did not exist in the past. Some have been made available, but many still do not exist and must be devised. In the last few years, fairly satisfactory methods for measuring some of the hormones, enzymes and vitamins have been developed through the use of colorimetric techniques, the spectrophotometer, etc. Another and not unimportant point is that any study of normal children may not elect to use techniques which require the periodic veni puncture of children and the withdrawal of considerable quantities of blood. Children don't like that sort of thing, and in the main won't stand for it if it is done at frequent intervals. The development of micro-techniques whereby several enzymes, ascorbic acid, serum protein, blood sugar in addition to red and white cells, hemoglobin and differential can all be measured from a few drops of blood taken from a child's finger, is therefore a tremendously important advance. The emphasis we are putting on the biochemical aspects of growth and development is the direct result of this advance in techniques.

Broadly put, we should hope to measure the ability of individuals to effectively survive in stress environments. It seems no more unreasonable for an individual, when selecting his life station and vocation, to take into account his so-called psychosomatic constitution than it seems unreasonable for him to take into account his level of intelligence and special aptitudes before attempting to study law or medicine.

These examples of our interests and efforts in the biochemical-physiological-medical areas of the study of human development do not constitute the whole research program of the

Fels Research Institute. They do represent, however, some of our basic studies which we hope will contribute toward the understanding of human development and function.

CHILD DEVELOPMENT IN RELATION TO COMMUNITY SOCIAL STRUCTURE[1]

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This is a summary of a group of studies which are being conducted under the auspices of the Committee on Human Development of the University of Chicago. These studies have the common factor of attention to community social structure as a powerful influence in child development.

The need for studies which emphasize the effects of the social environment on child development has become very clear in recent years. Of the three general approaches to the study of children - the psychological, biological, and sociological - the excellent research of the past thirty years has been long on the first two and short on the sociological.

At the University of Chicago a number of people from the departments of sociology, anthropology, education, and psychology have been working on collaborative, interdisciplinary studies which stress the factors of culture and community social structure in child development. The faculty members most directly concerned are Professors A. W. Brown, E. W. Burgess, Allison Davis, R. J. Havighurst, V. E. Herrick, F. A. Kingsbury, W. C. Seyfert, Caroline Tryon, R. W. Tyler, and W. L. Warner.

Basic Working Concepts

By community social structure is meant the various social groups in the community, their relationships to one another, and the change of these relationships with time. Insofar as the various social groups have markedly different habits and values - that is, insofar as the various social groups have different cultures - the structure of the community is a factor of great importance in causing the children of different groups to grow up so as to preserve these cultural differences.

The central working concept in these studies is that of social class. A social class is a group of people who participate together socially on intimate terms, or who would be willing to do so. Social class is a scientific refinement of the concept of

[1] *Paper presented at a general meeting of the Society for Research in Child Development in St. Louis, Mo., March 29, 1946.*

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socio-economic status, more useful because it divides people more definitely into different cultural groups. With the aid of the concept of social class, supplemented by those of ethnic and religious groups, it is possible to divide the people of a modern community most cleanly into separate culture groups.

The concept of social mobility is also essential in studies of modern communities. Social mobility is movement from one social class to another, a phenomenon which is characteristic of a democratic society. There are always some people in a modern democratic society who are in the process of adopting habits, manners, values, and goals of a social class different from the one into which they were born. They are mobile people who give the society its fluid, non-stratified aspect.

Current Studies

Using these working concepts of community social structure, the group at Chicago is making or has recently completed the following studies.

1. Child Development in a Typical Midwestern Community. The Committee on Human Development has selected a small midwestern city and its rural trading territory as a site for an extensive series of studies. The community comprises about half a county, with a population 11,000. It is typical of the agricultural-industrial communities which occur with great frequency in the midwest. By a number of census criteria this community falls close to average for its group.

Studies of the social structure of this community have been underway for four years. The social class composition of the city is now fairly well known, some three-fourths of the residents having been assigned to social class positions on the basis of information concerning their social participation and their socio-economic status. Special studies have been made of several ethnic and religious groups. The principal organizations of the community have been charted. At present one of the rural townships is being studied intensively, and its social organization will be related to that of the city.

These studies of social organization serve two purposes. They contribute to the growing fund of knowledge which social anthropology is building up concerning modern America; and they furnish the necessary background information for studies of child development in relation to community social structure.

Two groups of boys and girls are the subjects of the Study of Character Formation in an American Community. All the children born in the years 1926 and 1932 are included in this

study. The 1926 group were put under intensive investigation during the years 1943-1944, when most of them were in the junior and senior years of the high school. The 1932 group has been followed since 1942. Although the initial emphasis was on factors most closely related to moral character, the scope of the study has expanded to include the entire span of personality. Techniques range from the usual tests of attitudes and abilities to projective techniques such as the Rorschach and Thematic Apperception tests. The interview is a mainstay. The variables of social status and social mobility are being related systematically to the findings concerning character and personality.

During the course of this study, the school has emerged as a factor of great importance in the formation of character and personality of these children. It combines with the family to create the social environment of the child. The school is essentially middle-class in its values, its teaching, and its staff. The middle-class child finds the school reinforcing the goals, attitudes, and habits he has been taught in the home. On the other hand, the lower-class child finds the school attempting to teach him ways of behaving and believing which are not entirely what he has been taught at home. This child may turn toward the school, encouraged by his parents who want him to get from the school some of the skills and attitudes they cannot teach him, or he may turn against the school, and reject what it stands for, including its moral precepts.

Publications from this study will commence to appear in 1947.

2. Child-rearing Practices in Relation to Social Class and Color. This study has just been completed and will soon be published by Allison Davis and Robert J. Havighurst. A report on that part which deals with social class and child-rearing practices has been written by Martha C. Ericson and will appear in the American Journal of Sociology in 1946.

Two hundred Chicago mothers of young children were interviewed by a guided interview method concerning their practices in rearing their children. There were fifty each in four categories: middle-class white and Negro, and lower-class white and Negro.

The results show that the same types of differences exist between middle and lower-class Negroes as between middle and lower-class whites. Middle-class parents are more rigorous than lower-class parents in their training of children for feeding and cleanliness habits. They also expect their children to take responsibility for themselves earlier than lower-class parents do. Middle-class parents place their children under a

stricter regime, with more frustrations of their impulses, than do lower-class parents.

3. Parental Ideologies in Relation to Social Class. In a study completed in 1945, Evelyn Millis Duvall compared the concepts of "a good parent" and "a good child" that are held by women of four social class levels in Chicago, ranging from upper-lower class to upper-middle class. She found a systematic variation as her groups went up the social scale, regardless of whether they were Jewish, non-Jewish, or Negro.

4. Intelligence Test Performance in Relation to Social Class. It is generally understood that the ordinary verbal tests of intelligence consist mainly of problems and items drawn from the middle-class culture, and therefore probably penalize lower-class children, who do not have as much familiarity as middle-class children have with the vocabulary and the problem-situations that occur in the tests. Nevertheless, these intelligence tests are often used as a basis for assigning children to classes which are thought to be "homogeneous" in mental ability; furthermore, the tests are often used to decide what kind of curriculum a child should follow and what kind of educational opportunity is best fitted to his needs.

In order to evaluate more objectively the social-class factor in performance and intelligence tests, a project is now in progress which involves the testing of all the 9-, 10-, 13-, and 14-year-olds in a midwestern city of 100,000. All these children have been given five of the most widely used paper and pencil tests of intelligence. The same children are being located as to social status. Eventually an item analysis will be made of all the test items, for three groups of children at each age: upper-middle class, lower class of native or "old American" parentage, and lower class of ethnic parentage. Thus will be found the test items and types of items which differentiate most sharply and least sharply between children of various social classes.

5. A Comparative Study of the Development of Indian Children. A study of the development of American Indian children has recently been completed, with many of the same techniques that are being used in the study of children in a midwestern community. Children of five Indian tribes, mainly in the Southwest, were the subjects of this study. Thus it is possible to compare Indian children with white children and Indian children of various tribes with one another. Here the emphasis is upon cultural differences between societies, rather than upon cultural

differences between social classes within a given society.

The results of this study are being published in a series of tribal monographs* together with journal articles describing the results from specific techniques.

*Laura Thompson and Alice Joseph, The Hopi Way, University of Chicago Press, 1944.

Gordon Macgregor, Warriors Without Weapons (Sioux), University of Chicago Press, 1946.

Dorothea C. Leighton and Clyde Kluckhohn, The People and Their Children, A Study of the Navaho Indians, 2 volumes, Harvard University Press, 1946.

Alice Joseph, Rosamond Spicer, and Jane Chesky, The Desert People, A Study of the Papago Indians, University of Chicago Press (In Press).

PARENTS' ATTITUDES ON CHILD BEHAVIOR: A REPORT OF THREE STUDIES[1]

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With the improvement of research techniques, clearer insight into the factors in the environment which determine the child's behavior is being gained. A shift in the approach to the problem of personality has brought new understanding. At one time the behavior of the individual was viewed as possessing in, and of itself, the characteristic of truth and was judged mainly in terms of its logicality. Not only was there right and wrong behavior for a particular situation, but the behavior itself was felt to inhere directly in the situation or be a direct product of it. Situation is here used in the restricted sense to refer to stimulation immediately present at the time or just prior to the occurrence of the behavior.

We now have also moved from the study of the limited and specific situation to the study of contexts; both those which operate over a long period of time, and those which operate for a short period of time. A context operating over a substantial period of time produces effects in the behavior of children which are revealed in permanent, continuing or repeated tendencies of the child to act consistently in a variety of situations. On the basis of continuous or repetitive exposures, the child develops an image of himself, a level of aspiration, a point of view, or consistent attitudes with respect to his environment, which he will reflect in his behavior towards other individuals or his surroundings.

If, in some manner, the immediate situation can be freed of its constraints or limitations, these underlying trends may become manifested. In many, and perhaps most situations, organized responses appear, much as you put a penny in the slot and get a stick of gum. Skills and knowledges have become dissociated from the underlying motivating devices and, because they have acquired autonomy, reveal little or nothing of personality. Thus, if we ask a child the question "What is two plus two?" the answer four or even the wrong answers, five or three, are

[1] *Paper presented at a general meeting of the Society for Research in Child Development in St. Louis, Mo., March 29, 1946.*

Because of time restrictions, this report covers only a limited number of the studies recently completed or now in process at the Institute of Child Welfare.

ones that have been set and organized over a period of time. If, however, the constraints inherent in the situation are removed to permit some free play of expression, some opportunity of giving vent to feelings and spontaneous actions, we come nearer securing a picture of the child as he is. We are learning to use the unstructured and free situations as sources of scientific information about the individual.

I wish to describe three extensive studies, one of which is still in process, which are concerned with the relation between parents' attitudes and the goals they set for their children and the behavior of children among their fellows. I shall concern myself with general trends, rather than detailed statistics.

Dr. Radke,[2] who studied young children, obtained data from both parents of four- and five-year-old children by interview and a questionnaire, which covered many aspects of the parents' relations with their children and gave insight into the parents' philosophy as well as their ideas of their specific practices. For the children there was an interview about home practices and standards. Starting with such questions as "Tell me what is a good boy?" "What is a naughty boy?" she moved on to two projective techniques, in one of which the child represented or played out the relations within the family with dolls, and in the other of which he reacted to pictures showing typical family scenes both positive and negative in character. In addition, the children were tested for compliance to authority in an experimental situation, and teachers' ratings on the behavior of the children in school were obtained. Included in the questionnaire for the parents were questions which sought information about their disciplinary methods used with their own children as compared to those used on them as children of the preceding generation. A trend toward much less severe and much less emotional discipline with the change in generations, together with much greater respect for the child's personality, is revealed.

The data show that the children have a reasonably definite conception of their parents. If the child's view of the parents is contrasted with the parent's view of himself, it is clear that the child perceives the parent as much more severe in discipline than the parent conceives himself to be. The child looks upon the parent as the rightful authority but most frequently criticizes the parent for interference in the child's activities. The behavior patterns of the preschool children show patterns that are

[2] *This study is soon to appear as Radke, Marion J. Relation of parental authority to children's behavior and attitudes. (Institute of Child Welfare Monographs No. XXII.) Minneapolis: Univ. of Minnesota Press, 1946.*

related to the home atmospheres. Thus, significant differences in the favor of the democratic versus the autocratic atmospheres are shown in getting along with others, in considerateness, and in emotional stability; in favor of freedom-giving versus restrictive discipline atmospheres are shown in rivalry, in popularity and in colorfulness; and in favor of mild versus the severe punishment atmospheres are shown in talkativeness, rivalry, affection, considerateness and sensitivity. The choices which the child makes in the picture techniques are related to major aspects of his behavior and home life. The pictures give the child an opportunity to externalize his personal reactions to the home situation. While the doll play in this group of fairly normal well-adjusted children gave significant insights into the lives of some children, it proved to be of somewhat limited usefulness for group comparisons.

The second study by Miles[3] concerns social adjustment and leadership behavior at the adolescent level. In a community of 7,000 people with a high school population of 500 children, the children were divided into six groups on a basis of a multiple criterion based on five categories: (1) actual record of leadership positions in school and community, (2) a "Whom would you choose" blank, (3) a "Guess who" blank, (4) teachers' classification, and (5) an activities blank. Seventy children, 38 boys and 32 girls, were selected on the basis of these criteria and divided into the following groups: (1) successful leaders, (2) attempted leaders, (3) followers, (4) voluntary non-participants, (5) overlooked, and (6) outcasts. The children were given personality tests (the Bell Adjustment Inventory and the Rundquist-Sletto Survey of Opinions). Both parents, i.e., the father and the mother of each child, were interviewed separately. Each filled out a blank describing his attitudes or opinions with reference to home practices and chose from hypothetical descriptions of children on cards those descriptions which they wanted their children to be like and those they did not. There is available then for each child a record of his social relations to the groups, his own scores on adjustment inventories, together with important data with regard to parents' attitudes and conception of home training along with sampling and face-sheet data on parent education, socio-economic status, etc. The results indicate significant relation between the social behavior of the children and the socio-economic status and education of their

[3] *Miles, Katherine A. Relationship between certain factors in the home background and the quality of leadership shown by children. Ph.D. thesis. University of Minnesota, September, 1945. (To be published later.)*

parents; a result consonant with the literature. They also indicate a very definite relation between the parents' opinions with regard to the training of the child and the status the child achieves in his own social group and a significant relationship between personality measures and the status achieved in the social groups. When the scale for parents' opinions and practices was broken down into sub-scales, measuring (1) overprotection, (2) dominance, and (3) encouragement of social development, there is also a significant relationship to the child's position in his social group. The results indicate rather clearly that a variety of factors in the context of a child's life are of some relation to the behavior which he shows in his relations to other children and both in turn are related to personality measures. When an item analysis was run between the 121 separate items on the attitude scale, and the 66 on the "Choose your child" scale and an outside criterion based upon the children's behavior in their social groups, interesting relations were found. A second item analysis, based on the correlation of the separate items with total score, also yielded significant results.

If we look at the particular items on the parental attitude scale which seem to have very high value in predicting parental child behavior, we find items such as:

"If a twelve-year-old receives an allowance, his parents should plan with him in detail how it is spent."

"A parent should feel free to read a high school child's letter without first asking permission."

"Children under eight years old should not be allowed to climb trees for fear of broken bones."

Items which have no or little discriminative value are ones such as these:

"Parents should carefully supervise the friendships of adolescent boys and girls."

"Parents should not allow children under twelve years of age to play with undesirable companions."

"Girls over eight years old should make their own beds."

"No parent should ever be satisfied with his child unless he is in some way a leader."

On the "Choose Your Child" scale, typical items which have high discriminative value, in terms of child behavior, are:

"This child cannot stand any form of adverse criticism."

"This child is persistent even in the face of difficulty."

"This child is so tactful that he has unusual ability to get along with other children."

Typical items with no or little discriminative value are:

"This child is easily discouraged when facing difficulties

which can be solved by the ordinary child."

"This child is always good-humored and pleasant to be with."

"This child is not forward; he never pushes himself to the front in any group."

"This child is so cautious and careful that he weighs all possibilities before he finally reaches a decision."

It is interesting to look over the items that discriminate and those that do not. In advance, it would be very difficult to tell which ones will and which will not; in fact, there is no a priori method by which they can be selected. Nevertheless, they do hang together in patterns and, after selection, seem to have some logicality. It seems clear to me that such statements given cannot be interpreted in terms of right or wrong or in a precise way as indicating what the actual practices within the particular family are. They do indicate how parents feel and how they verbalize their feelings about children, and picture indirectly their goals and aspirations.

I quote from the Miles' report: "Attitudes of parents appear to be crucial factors which are closely related to the social behavior of children. Parents of successful leaders show outstandingly different attitudes from the parents of other groups of children. The contrast is most marked when they are compared with parents of asocial children, especially parents of outcasts and overlooked children. In general, parents of successful children are less inclined to protect children from the normal risks of life, to shield them from the normal responsibilities of life and to prevent them from developing an adequate degree of independence which is so necessary for good mental health and normal functioning in the social group. Also, they tend to be less restrictive in the degree of control which they exercise over the child. Much more leeway is allowed the children in making decisions, using judgment and experimenting with new situations. Also the individual personality is given far more respect - his rights and his opinions are given consideration in the family group. In addition, parents of successful children appear to possess superior ability in evaluating forms of child behavior and characteristics of child personality which are desirable for the optimum development of the child himself." (p. 228)

The third study by Frank Hansen in the series is now in process. Essentially it consisted of taking the instruments devised in the Miles' study at the adolescent level, particularly those relating to parents' opinions with regard to practices and ideals for their children and those developed in the Radke investigation, consisting of pictures presenting family situations and child-adult situations, the Radke attitude scale and doll play

procedures, and applying them to the population of a summer camp composed of children of elementary school age. The results obtained will be checked against the social behavior of the children in their groups, their relations with counselors and their relations with camp officials. From this we not only expect to get a picture of the inter-relationships between the Radke techniques and the Miles' techniques, but also to obtain substantial information on the child at the elementary school level - an age level somewhat neglected in the past as an area for research on problems of this type.

Some generalizations can be made from the studies already made which may well be verified when the Hansen study is completed. These are:

1. The child has definite impressions of his parents and has formed an image or concept of them. This can be revealed in normal children by modified projection techniques. The major image or concept is often very different from what the parents themselves would expect. This concept tends to emphasize the disciplinary and management controls exercised by the parents, rather than their positive approaches or affection for the child. The child tends to see parents more as frustrating than as facilitating beings.

2. Parents have very definite attitudes with respect to the management of children. These attitudes cluster in patterns and make up a context from which any single item may diverge, without affecting the major relations in the whole series. There is a relation between the behavior of the child in his own social group with his peers and the parents' opinions or attitudes.

3. The parent also has an idealized child against which he compares or rates the behavior of his own child. This ideal varies with the education and socio-economic status of parents, as well as with their attitudes and opinions on matters of training children. There is a relation between the parents' concept of the ideal child and the behavior of the child in his own social groups.

4. There is a relation between children's behavior in social groups and scores made on personality measures, and between the parents' attitudes, opinions and goals for children and the scores made on personality measures.

5. The relations are clearest and most distinctive for the children who are most distinctive in social behavior, i.e., for successful leaders and the overlooked or social outcasts.

6. Some of the methods here described give promise of usefulness in measuring or studying contexts. It would seem to be most appropriate not to regard them in terms of logicality, but to work with them in terms of empirically determined patterns

or clusters, and to explore the possibilities of differential scoring for different items or responses.

DOLL PLAY AS A FUNCTION OF THE DOLL FAMILY CONSTELLATION[1]

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Projective doll play, in recent years, has gained increasing prominence as a diagnostic and therapeutic measure for dealing with children's adjustment difficulties. Through the medium of dolls the child may express his attitudes toward his world and the people in it, his fears and anxieties, his affection and aggression, his needs and motives. In the relatively "objective" play situation he may reveal and work through the problems, effecting catharsis and insight.

Much of the literature on projective play has presented interpretive rather than methodological studies, reviewing individual case histories instead of experimental data. Various materials and methods have been used, each therapist determining the extent of his participation in the situation and the structure and relative freedom of the play. The child's identification with the dolls, in some cases, has been forced and, in others, has been allowed to appear spontaneously.

Investigation of the quality and content of young children's fantasy behavior in doll play as a function of certain demonstrable variables has been the general purpose of a series of studies in projective play done at the Iowa Child Welfare Research Station (1, 9, 10, 11, 12, 14). A methodological approach to the problems of identification and aggression has been attempted in the present study (12). The relationship of behavioral signs of a child's identification with the dolls to other factors in the play situation has not previously been discussed to any extent by psychiatrists or experimenters.

Conn (3) and Solomon (13) centered the child's play around his specific problems by creating a situation with dolls representing the actual characters involved. Although the doll which stands for the child is the most important one, Solomon felt that identification should not be forced, and recommended that the child not be made to feel that the play refers to himself. In Levy's (7) experimental studies of sibling rivalry, in which the child was presented with a mother doll, a baby doll, and a doll representing himself, identification with the self doll was inferred.

[1] *This is the fifth in a series of studies of projective doll play performed at the Iowa Child Welfare Research Station under the direction of Dr. Robert R. Sears.*

Despert (4), in examining the personality reactions of preschool children, gave her subjects four dolls, a man, a woman, a baby, and a boy or girl, according to the sex of the particular child. She found that each child identified in some manner with the dolls and that aggression, the most striking aspect of the play, was often directed at members of the family whom he identified.

Investigating doll play as an aid to understanding and guiding the normal preschool child, Baruch (2) offered dolls duplicating the subject's family constellation. The child was helped by the examiner to identify the dolls with his own family if he did not do so of his own accord.

Bach (1) introduced a minlature preschool set with a teacher doll and three child-dolls, one of which was an "identification doll" with which the child was urged to identify. It was found that stimulation to identification, if pressed too far with certain children, was met with resistance.

The present study had as its purpose, generally, to determine the effects of using in a projective play situation dolls which represented the child's own family constellation, as compared with a standard set of dolls; and, specifically, to examine the extent, kind, and direction of aggression, the amount and type of thematic play, and the frequency of identification under these experimental conditions.

Method

Experimental Variables

Two variables were considered in this study: 1) the type of doll family, as to whether it did or did not duplicate the child's own family, and 2) the presence or absence of siblings in the child's own family. The 50 children used as subjects were divided into four groups as follows:

I. No sibling, dolls duplicate own family
II. One sibling, dolls duplicate own family
III. No sibling, standard doll family
IV. One sibling, standard doll family

Groups I and II, which together may be called the Duplicated Family group (DF), received a set of dolls designed to represent the immediate family constellation of each subject, i.e., the people residing in his home. Only dolls that represented parents, siblings, and relatives were presented; roomers and student help were not included. If the subject's father was away from home, no father doll was offered. If he was at home, but in the armed service, the doll was dressed in the appropriate uniform. Sibling dolls were identifiable as to sex and age in

relation to those of the doll representing the child, i.e., the size of these dolls varied to indicate a difference in ages. Instructions, dependent upon the subject's family constellation, were worded to induce identification with the dolls.

Groups III and IV, together called the Standard Family group (SF), were presented with a standard set of five dolls which did not represent the subject's own family. It included a civilian father, a mother, a boy and a girl of the same size, and a baby. Standard instructions were given.

The organized house furnishings (Figure 1) were the same for both groups with one exception; in the DF group, the crib and high chair were removed if there was no baby in the subject's family.

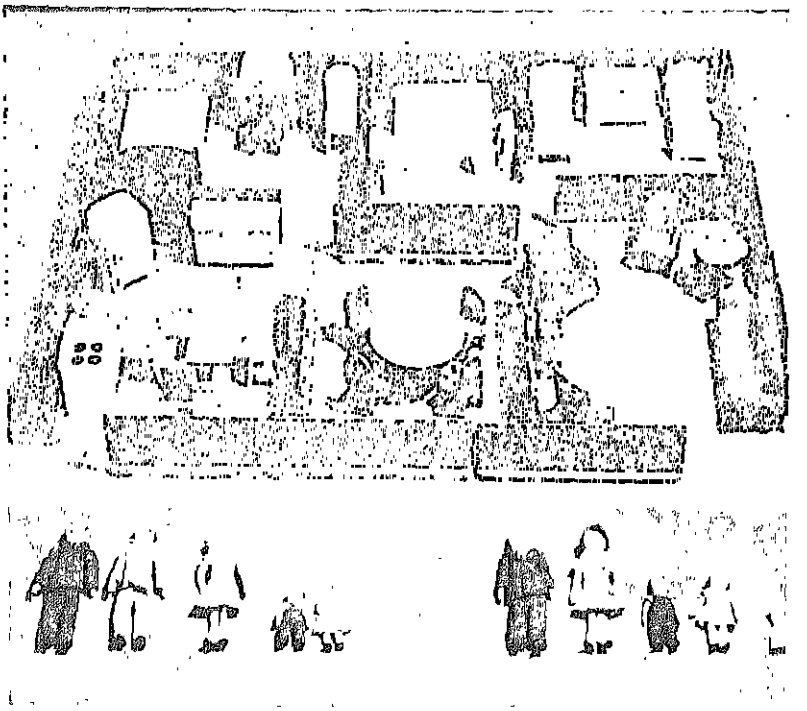

Figure 1. Experimental materials: standard family dolls at the right, additional dolls for duplicated family at the left.

Subjects

The subjects were 50 children from the Preschool Laboratories of the Iowa Child Welfare Research Station in Iowa City, and from the Crocker School, the Jewish Community Center,

and the Salvation Army Center in Des Moines. Thirty-five children were from the Preschool Laboratories, and 15 from the Des Moines schools.

The DF and SF groups were equated for 1) age, 2) sex, 3) the number, relative age, and sex of siblings, 4) the father's being at home or away from home, i.e., in the armed service or traveling for business, 5) extra members of the household, e.g., relatives, roomers, student help, and 6) amount of previous experience in doll play procedures. Matching with regard to family constellation was made on the basis of the family group as it existed during the month preceding the experimental sessions.

Each group was composed of 13 boys and 12 girls. There were 18 children with no sibling and 32 with one sibling, these being distributed equally in the DF and SF groups.

The chronological age range of the total group of subjects was from 3-2 to 6-2, with a mean age of 4.6 years. The mean chronological ages of the children in the four subgroups varied from 4.5 to 4.7 years.

The amount of each child's previous experience with doll play procedure in the Phillips (9), Pintler (10), and Yarrow (14) experiments was considered in matching the subjects. The children who were without previous experience were given preliminary sessions by another examiner at least a month before the experimental sessions in order to familiarize them with the situation. The amount of former experience for all children ranged from 40 to 80 minutes.

Experimental Materials

The experimental materials consisted of 10 clothed, life-like dolls, a set of realistic doll furniture, and 15 composition wall pieces. The wooden furniture, specially constructed for the experimental work, was made to the scale of one inch to a foot and was proportional to the size of the dolls used. Presented in an organized form, the house was 32 inches long and 25 inches wide. The furniture for the kitchen consisted of a sink, a refrigerator, a stove, a table, three chairs, and a high chair; for the dining room, a round table and four chairs with blue cloth-covered seats; for the living room, a radio, a small table, a davenport and three easy chairs, upholstered in red, green, and blue; for the parents' bedroom, a double bed, a crib, and a dressing table and chair; for the children's bedroom, two single beds and a dresser; and for the bathroom, a toilet, a tub, and a washbowl. The walls with small wooden bases were made of sturdy composition material. The height was three and one-fourth inches, and the lengths varied, six, nine, and sixteen

inches.

None of the pieces was stationary, so there was great opportunity for rearrangement and organization. In order to reduce as much as possible the subject's exploratory behavior, the furniture possessed no manipulative parts; for example, the faucets would not turn, the toilet seat and cover were nailed in place, the refrigerator door would not open, and there were no removable drawers.

The dolls were made of string wrapped around a pipe cleaner base and were dressed in unremovable, colorful cotton clothes. The hair was composed of woolen yarn, and the shoes, painted brown, were molded from papier maché. Three adult male dolls, dressed in Army, Navy, and civilian suits, measured six inches in height; two adult female dolls, five and one-half inches; two sets of boy and girl dolls, three and one-half and two and one-half inches; and a baby doll, one and one-half inches. Clothes and hair of different colors differentiated dolls of the same sex and size. Light and flexible, the dolls were easy for the child to handle and could be placed in a sitting or standing position.

Procedure

Two experimental sessions, each a half-hour in length, were presented approximately 48 hours apart under conditions of Pintler's (10) high experimenter interaction. Such interaction consisted of 15 to 20 verbal contacts with the child every five minutes; these were limited to establishment of rapport, stimulation to stay in the experimental situation, and general stimulation to thematic elaboration.

As the child was brought to the experimental room, the experimenter carried on a friendly conversation with him and attempted to provoke a pleasant anticipation of the toys. Upon entering the room the child was shown the materials. The instructions given varied for the DF and SF groups. To the children of the SF group the experimenter said, "Here is a family of dolls and the house that they live in. You may play with them any way you like." Instructions for the DF group were altered to fit the family constellation of each subject; e.g., "Here is a family of dolls and the house that they live in. See, here is the mother, the little girl, and her baby brother. Daddy is away in the Army. You may play with them any way you like."

After introducing the materials, the experimenter, seated on the floor near the child, immediately started to record the child's behavior and the experimenter-child interactions. Throughout the sessions the experimenter maintained a friendly interest in and a non-evaluative attitude toward the child's ac-

tivities.

The child's behavior was recorded in 15-second samples by use of a notational system adapted to a great extent from that used by Phillips (9) and Pintler (10). An automatic timing device buzzed every 15 seconds to mark the time. For the majority of the categories, judgments were made during the interval but were recorded at the end of it, when the buzzer sounded the termination of the interval. The remainder, including instances of aggression, identification, inappropriate action, metamorphosis, and experimenter-child interaction, were recorded at the instant they occurred.

Questions sometimes arose regarding the experimenter's recordings and the buzz of the timing device. In response to curiosity concerning the sound, the experimenter explained that it was a clock in another room which kept time by buzzing every 15 seconds. If the child inquired about the recordings, the experimenter replied that it was just a way of keeping track of the dolls and the furniture and directed his attention back to the materials. Throughout the sessions an attempt was made to keep the child from realizing that there was any relationship between his activity and the recordings.

Categories and Scoring

Categories were designed to describe the behavior of the child and were recorded in terms of their corresponding symbols.[2] Several of the categories are essentially the same as those discussed by Phillips (9); E, exploratory; O, organizational behavior; T, tangential activity; P, tangential play; and Th, routine (stereotyped) thematic play. In addition, the following categories were used:

ITh - Individualized thematic play

Any thematic action or verbalization, with or without dolls, indicating a situation which is not defined under routine thematic play or in which the materials are not used according to their given purpose, e.g., warfare, earthquake, train or airplane rides, and school or hospital scenes (involving metamorphosis).

M - Metamorphosis Cf. Bach (1)

A change in role or meaning of the dolls or equipment. For example, the bathtub may become an automobile; the home, a school; the father doll, a bomb.

x - Inappropriate action

Nonaggressive action or organization of materials which is inappropriate to the ongoing theme, e.g., washing dishes in the living room, or the father's sleeping in the baby's crib.

[2]*For a detailed description of categories and scoring procedure see Robinson (12).*

1 - Identification

Activity or verbalization in which the child relates himself or his family to a theme or the experimental materials. This may include the use of the pronoun "I" with reference to a doll, thematic action, or experience; calling a doll by his own name; identifying dolls with members of his own family; relating thematic action to his own or family experiences; assuming a role and acting thematically himself, as indicated by a statement to this effect; and favoring or showing emotional concern about a particular doll.

Aggression

Hostility as expressed in action or implied through tone of voice and content of speech. Interpretations are in accordance with the definition by Dollard, Doob, Miller, Mowrer, and Sears (5): "Any act whose goal response is injury to an organism (or organism-surrogate)." Hostility may be directed from the subject to the dolls, to the other experimental materials, or to the experimenter, or from the dolls to each other or to the equipment.

Two kinds of aggression have been considered, *stereotyped* and *nonstereotyped*.

> Stereotyped aggression
>
> Any form of aggressive behavior which may actually occur in the average, middle-class home situation; assertive actions or verbalizations which are appropriate to time, place, character, and capability of the agent of aggression.
>
> Nonstereotyped aggression
>
> Any form of aggressive behavior, distinguished from stereotyped aggression by its intensity, inappropriateness, or individualistic quality, which would not be expected in average home relationships.

Examples of stereotyped and nonstereotyped aggression in doll play are listed in Table 1.

Location of thematic play

The following symbols were used to indicate the location of thematic play:

K Kitchen	Bp Parents' Bedroom
D Dining Room	Ba Bathroom
L Living Room	O Outside the house
B Children's Bedroom	

Recording of behavior

Behavior was recorded on mimeographed score sheets, composed of four rows of twenty 15-second interval spaces on a side, each row being subdivided for notations of the location of thematic play, general behavior categories, and instances of aggression. Six kinds of notations were used.

1. Each change in the location of thematic play was indicated by the appropriate symbol in the location line.
2. The corresponding symbol was recorded in the behavior line for action characteristic of the general behavior categories (E, O, Th, ITh, T, P) which continued longer than one-half of a 15-second interval.
3. The symbol for metamorphosis was recorded once above the location of theme line at its first occurrence.
4. Instances of identification and inappropriate action or organization were noted in the general behavior line once per 15-second interval in each interval in which they occurred. If they occurred twice in one interval, only one symbol was recorded.
5. Instances of aggression were recorded in the aggression line as they occurred, the agent, object, and kind of aggression being noted.
6. Experimenter-child interactions were tallied below the aggression line.

Table 1

Examples of Aggressive Behavior in Doll Play

Stereotyped Aggression	Nonstereotyped Aggression
I. General	I. General
1. Arguing, quarreling	1. Hitting, or beating, violently and injuriously
2. Commanding (in aggressive tone)	2. Kicking, knocking down
3. Scolding	3. Jumping on, trampling, breaking
4. Threatening	4. Throwing or whirling
5. Criticism of behavior	5. Knocking over or out of furniture, including stove, sink, toilet
6. Depreciation of person	6. Doll as some type of witch, giant, animal, inanimate object with destructive accompaniment
7. Attribution of bad qualities	7. Trapping
8. Swearing	8. Killing
9. Teasing	9. Any hostile or destructive act of which the child would be incapable in real life
II. Parent to child (doll)	II. Parent to child (doll)
1. Any of the general examples	1. General examples
2. Sending to bed	2. Hitting
3. Sending away from table	3. Hitting from adult-on
4. Isolation	
5. Deprivation	III. Parent to parent
6. Spanking or slapping	1. General examples
7. Refusal of requests	2. Physical fighting, e.g., hitting, kicking, spanking
8. Restriction or prohibition of activity	
9. Forcibly taking away objects	IV. Child to parent
III. Parent to parent	1. General examples
1. General examples	2. Spanking
IV. Child to parent	
1. General categories	
2. Refusal to comply with requests	

Examples of Aggressive Behavior in Doll Play

Stereotyped Aggression	Nonstereotyped Aggression
3. Hiding	V. Child to child
4. Running away	1. General examples
5. Crying	
V. Child to child	VI. Subject to dolls or equipment
1. General examples	1. Spanking, hitting, slapping with intensity or strong emotional involvement
2. Fighting	2. Stepping on or breaking dolls or furniture
3. Hitting	3. Having dolls trip or fall off or over furniture
4. Kicking	4. Having a character die
VI. Subject to dolls or equipment	5. Banging or pushing over doll furniture or walls
1. General categories	6. Having a storm blow down the house or furniture
2. Spanking, hitting, or slapping the dolls	7. Child assuming the role of a destructive agent

Aggression was recorded by notation of agent, object, and kind (stereotyped or nonstereotyped). Symbols used to indicate agent and object of aggression were:

Agent

- b Baby doll
- c The subject
- d The doll which represents the subject; the "self doll." In the SF group, d is the child doll of the same sex as the subject
- f Father doll
- gf Grandfather doll
- gm Grandmother doll
- l Fantastic agent, something not human but which may appear animate or dynamic to the child, e.g., witch, fairy, animal, storm. Also, a person outside the family constellation
- m Mother doll

q Other experimental materials, i.e., furniture, walls
s *Sibling doll, other than the baby*
fam Two or more dolls of the family group

Object

The above symbols were also used to designate the object of aggression. In addition, the symbol x denoted *aggression toward the experimenter.*

A combination of symbols was recorded at each instance of aggression, e.g., *aggression* from the mother to the baby was recorded as mb, or from the subject to the furniture as eq. When the source of aggression was not indicated by definite action or verbalization, the subject was considered as the agent. Because of the predominance of nonstereotyped aggression, no additional symbol was used to qualify it. If the aggression was stereotyped, an S was placed to the right of the direction symbols, i.e., fdS. Each instance of aggression was recorded in a 15-second frame of reference, and statistical analysis was made in terms of the total number of instances during the sessions.

Reliability

Reliability of the scoring method was determined by simultaneous observation with another observer (Yarrow) during 295 minutes of doll play carried out under the conditions described for the SF group. One observer served as experimenter in the room with the child, while the other observed the activity from an observation chamber fitted with a one-way screen.

The statistical procedure used was that of percentage of agreement between observers. Percentages of agreement on the general behavior categories, totaled and separate, and instances of identification, inappropriate action, metamorphosis, and occurrence of aggression, were computed by the formula:

$$\frac{\text{2 times the total number of agreements of observers A and B}}{\text{the total number of observations of A plus B}}$$

Percentage of agreement on direction, agent, object, and kind of aggression were determined by the formula:

$$\frac{\text{2 times the number of agreements of A and B on the item}}{\text{the total number of agreements of A and B on the occurrence of aggression}}$$

The criteria for agreement were:

1. For the general behavior categories (E, O, T, P, Th, and ITh): the same symbol recorded in the same 15-second interval by each observer.
2. For all other categories, except identification: the same item of behavior recorded within two adjacent 15-second intervals by each observer. Here, the interest lay in the

frequency rather than the sequence of occurrence. Reliability for identification was determined within a one-minute frame of reference.

The criteria for disagreement were:

1. Omission of an item of behavior by one of the observers.
2. Failure to record items of behavior according to the criteria for agreement.

The percentages of agreement are presented in Table 2. It is interesting to note that, despite the low percentages of agreement on tangential and tangential play, there was never any disagreement between these two categories.

Results

Mean Frequencies of Behavior

The mean frequency of each category of behavior during the two 30-minute sessions of doll play under four combinations of experimental variables is presented in Table 3. The No Sibling groups contained 9 subjects; and the One Sibling groups, 16 subjects. No outstanding differences among the variables were noted, except in the case of identification, of which there was a greater amount in the DF groups. There was also more organizational behavior and less routine thematic play in the DF-No Sibling group.

A distinction was made between thematic and nonthematic aggression. Instances of aggression which occurred in conjunction with routine or individualized thematic play were designated as thematic; those occurring with exploratory, organizational, tangential activity, or tangential play, as nonthematic.

It is interesting to note the wide discrepancy between certain behavipr categories under all experimental conditions. There was predominantly more organizational than exploratory behavior, more thematic than tangential activity, more routine than individualized thematic play, and more tangential activity than tangential play. Thematic aggression exceeded nonthematic aggression; and, in contrast to the results found with regard to thematic play, individualized thematic aggression was greater than routine thematic aggression. Nonstereotyped aggression was strikingly more frequent than stereotyped aggression.

No statistical analysis was made of location of thematic play or of direction of nonthematic aggression.

TABLE 2

FREQUENCY OF OCCURRENCE AND PERCENTAGES OF AGREEMENT BETWEEN TWO OBSERVERS' RECORDINGS OF THE VARIOUS CATEGORIES DURING 295 MINUTES OF OBSERVATION FOR RELIABILITY OF THE SCORING METHOD

Category	Frequency	Percentage of agreement
Total general behavior categories (E, O, T, P, Th, ITh)	2306	89.0
Exploratory	259	81.8
Organizational	427	87.6
Tangential	52	65.4
Tangential play	33	54.5
Routine thematic play	1307	93.2
Individualized thematic play	281	89.7
Metamorphosis	15	80.0
Inappropriate action	110	80.0
Identification	19	84.2
Aggression		
Occurrence	500	78.8
Direction	*394	79.2
Agent	*394	87.8
Object	*394	82.2
Nonstereotyped	336	83.9

*Percentage of agreement was based upon the total number of agreements on the occurrence of aggression mentioned by each observed.

Differences Between Mean Frequencies of Behavior

Table 4 shows the reliabilities of the differences in mean frequencies of behavior between the DF and SF groups and the No Sibling and One Sibling groups. The scores of the children in the DF group were compared with those in the SF group, and those in the No Sibling group with those in the One Sibling group. Each group was studied as a whole. Although the subjects were selectively distributed among the experimental groups on the basis of several criteria and were thus possibly more closely related than would be children drawn entirely at random, they were not matched individually in each group. Therefore, Lindquist's formula for the significance ratio (t) of the difference between the means of independent random samples was used (8,

TABLE 3

MEAN FREQUENCIES OF BEHAVIOR DURING TWO THIRTY-MINUTE SESSIONS OF DOLL PLAY UNDER FOUR COMBINATIONS OF EXPERIMENTAL VARIABLES

Category of Behavior	DF-No Sibling N = 9	DF-One Sibling N = 16	SF-No Sibling N = 9	SF-One Sibling N = 16
Exploratory	20.4	20.1	19.0	27.3
Organizational	71.0	40.7	49.8	47.8
Tangential	21.6	24.0	35.4	29.3
Tangential play	13.9	14.6	11.4	17.2
Routine thematic play	76.1	68.4	69.1	67.3
Individualized thematic play	36.4	41.6	34.3	31.0
Metamorphosis	1.8	2.2	2.3	1.1
Inappropriate action	9.2	6.8	6.7	8.3
Identification	7.6	5.9	3.1	1.7
Total aggression	43.2	40.1	37.1	43.1
Nonthematic aggression	13.9	13.4	11.4	14.2
Thematic aggression	29.3	34.6	25.7	28.8
Routine thematic aggression	10.0	8.0	8.9	10.1
Individualized thematic aggression	19.3	26.6	16.8	18.8
Stereotyped aggression	2.6	3.0	4.0	3.3
Nonstereotyped aggression	40.7	45.1	33.1	39.8

p. 138). Results in the table are given in terms of the difference between the means and the level of confidence (1 of c) for this difference.

With the DF condition, identification was significantly greater, at better than the one percent level of confidence, than with the SF condition. There was a slight tendency (at the 20 percent level) toward more exploratory behavior in the SF than in the DF group, and more organization of materials in the No Sibling than in the One Sibling group.

Direction of Thematic Aggression

Instances of thematic and nonthematic aggression were classified according to agent and object. Each experimental group differed in its combination of variables, and, therefore, no consistent pattern of dolls was presented to all the subjects. The categories of direction which each group had in common, how-

TABLE 4

SIGNIFICANCE OF THE DIFFERENCES IN MEAN FREQUENCIES OF BEHAVIOR BETWEEN THE DUPLICATED FAMILY AND STANDARD FAMILY GROUPS AND THE NO SIBLING AND ONE SIBLING GROUPS (N = 50)

Category	Duplicated Family–Standard Family		No Sibling–One Sibling	
	Mean Diff.	l of c	Mean Diff.	l of c
Exploratory	*4.4	20	*3.5	30
Organizational	7.1	50	13.5	20
Tangential	*8.0	40	1.6	90
Tangential play	*0.8	90	*3.2	60
Routine thematic play	*1.5	--	*7.2	70
Individualized thematic play	7.6	40	*0.9	--
Metamorphosis	0.4	70	0.4	70
Inappropriate action	*0.2	--	0.5	80
Identification	4.3	1	1.5	40
Total aggression	5.4	60	*5.4	60
Nonthematic aggression	0.4	—	*1.1	90
Thematic aggression	5.0	50	*4.2	60
Routine thematic aggression	*0.9	70	0.4	90
Individualized thematic aggression	6.0	40	*4.6	50
Stereotyped aggression	*0.8	50	0.1	—
Nonstereotyped aggression	6.1	70	*5.5	60

* Greater frequency in the second-mentioned variable.

ever, were the subject himself, the "self doll," the mother doll, a family group of two or more dolls, a fantastic agent, the experimental materials, and the experimenter.

Table 5 presents the mean frequencies of agents and objects of thematic aggression under each combination of variables. There was somewhat more aggression emanating from the mother doll, sibling doll (other than baby), and fantastic agent under the DF than under the SF condition. Aggression toward the mother doll was greater with the DF condition. The self doll and father doll, as well as the grandmother doll, were the objects of more aggression in the DF-No Sibling group than in any other group. In the DF-One Sibling group the experimental materials, the sibling doll, the family, and particularly the baby doll, received more aggression than in other groups.

Differences in Direction of Thematic Aggression

Further analysis of thematic aggression was made for sev-

TABLE 5

MEAN FREQUENCIES OF AGENTS AND OBJECTS OF THEMATIC AGGRESSION DURING TWO THIRTY-MINUTE SESSIONS OF DOLL PLAY UNDER FOUR COMBINATIONS OF EXPERIMENTAL VARIABLES

Category	DF–No Sibling	DF–One Sibling	SF–No Sibling	SF–One Sibling
Agent of aggression				
b Baby doll	—	0.7 (3)[1]	0.1	0.6
*c The subject	21.0	24.3	21.1	20.7
*d Self doll	1.2	1.4	1.2	0.9
f Father doll	2.5 (6)	2.1 (10)	1.2	2.8
gf Grandfather doll	—	0.0 (1)	—	—
gm Grandmother doll	0.0 (1)	0.5 (2)	—	—
*l Fantastic agent	3.2	3.2	0.7	2.0
*m Mother doll	2.1	1.7	0.7	1.1
*q Experimental materials	0.1	0.1	0.0	0.1
s Sibling doll	—	1.5 (13)	0.4	0.1
*fam Family (two or more dolls)	0.0	1.2	0.2	0.4
Object of aggression				
b Baby doll	—	11.0 (3)	4.0	4.2
*c The subject	0.2	0.0	0.0	0.2
*d Self doll	0.1	3.5	3.4	3.2
f Father doll	7.0 (6)	4.6 (10)	4.2	5.4
gf Grandfather doll	—	0.0 (1)	—	—
gm Grandmother doll	3.0 (1)	1.5 (2)	—	—
*l Fantastic agent	0.2	0.4	0.1	0.6
*m Mother doll	7.4	7.0	3.4	3.7
*q Experimental materials	5.8	8.6	3.8	5.6
s Sibling doll	—	5.9 (13)	2.2	1.9
*x Experimenter	0.0	0.1	0.2	0.3
*fam Family (two or more dolls)	2.6	5.2	3.4	3.7

* Categories that all groups had in common.

1. The numbers in parentheses indicate the number of children who were presented with these dolls; mean frequencies were based upon these cases.

eral categories which were comparable for each experimental group. Significance of the differences in mean frequencies of thematic aggression between the DF and SF and the No Sibling and One Sibling groups, shown in Table 6, was computed for the agents (the subject, self doll, and mother doll) and objects of aggression (self doll, mother doll, and experimental materials).

TABLE 6

SIGNIFICANCE OF THE DIFFERENCES IN MEAN FREQUENCIES IN DIRECTION OF THEMATIC AGGRESSION BETWEEN THE DUPLICATED FAMILY AND STANDARD FAMILY GROUPS AND THE NO SIBLING AND ONE SIBLING GROUPS (N = 50)

Category	Duplicated Family–Standard Family		No Sibling–One Sibling	
	Mean Diff.	1 of c	Mean Diff.	1 of c
Agent of aggression				
c The subject	2.3	70	#1.4	80
d "Self doll"	0.4	60	0.0	--
m Mother doll	0.9	30	0.0	--
Object of aggression				
d "Self doll"	1.9	20	2.4	10
m Mother doll	3.6	5	0.1	--
q Experimental materials	2.6	40	#2.3	40

Greater frequency in the second-mentioned variable.

No significant differences appeared with regard to the agent of aggression. As an object of aggression, the self doll received somewhat reliably more aggression (10 percent 1 of c) in the No Sibling group than in the One Sibling group, and there was a tendency for this to happen also in the DF group. Greater aggression toward the mother doll in the DF group was relatively significant at the 5 percent level.

Comparison of Identifying and Non-identifying Children

Children who manifested instances of identification were compared with those who did not with regard to individualized thematic play, total thematic aggression, individualized thematic aggression, and nonstereotyped aggression. Thirty-seven children, 17 boys and 20 girls, showed some form of identification. All but three of the 25 children in the DF group identified, while in the SF group, 10 children failed to do so. Five of the 18 children with no sibling and 8 of the 32 children with one sibling did not identify.

Identifiers showed a slight tendency (20 to 30 percent 1 of c) to exhibit more individualized thematic play than non-identifiers,

but no significant trend was observed for total thematic, individualized thematic, and nonstereotyped aggression. A correlation ratio of -.50 (standard error ±.16) between identification and total thematic aggression was obtained (6).

Discussion

The variables under consideration in this study appeared not to influence significantly the general behavior categories, with the exception of identification, and did not produce results outstandingly different from those of the previous doll play research in this series.

It has been assumed that identification is inherent in projective doll play. The significance of the extent and manner in which overt signs of identification vary with certain experimental conditions and correlate with other measures of observable behavior may be of interest in determining its importance in the clinical situation.

Children in the DF group were presented with dolls which duplicated their own family constellations and were given instructions designed to induce identification. Instances of identification were shown to be significantly greater (better than the one percent level of confidence) in this group than under the SF condition.

With such a large difference in identification between the DF and SF groups one might expect to find a corresponding difference in the type and amount of thematic play or aggression exhibited. But this does not seem to be the case; routine and individualized thematic play, as well as aggression, did not vary significantly with these variables.

An analysis of the changes in thematic aggression which may be predicted from changes in identification was made for the 37 children who showed identification. Instances of identification ranged from one to 19 and those of aggression, from one to 96. A slight, negative, curvilinear relationship between the identification and aggression of these children was indicated by the correlation ratio (-.50; standard error ±.16). There was a slight tendency for thematic aggression to decrease as identification increased. This relationship, however, did not hold for all cases. Low thematic aggression was generally associated with high identification and the relationship was moderate near the mean of the distribution, but low identification did not always result in high aggression. Children who had from one to three instances of identification gave from one to 96 instances of thematic aggression. The scatter of aggression scores was more limited at the high identification portion of the scale. An

arbitrary division of thematic aggression and identification scores and their corresponding case frequencies may illustrate this relationship.

Identification	Aggression			
	1-22	23-44	45-66	66-96
1-3	5	5	3	4
4-12	7	8		
13-19	5			

Bach (1) found that, with regard to the fantasy behavior of a group of seven children who identified with his "identification-doll," as compared with an equal number of non-identifiers, the latter group showed significantly fewer "nasty" fantasies, less associated aggression, and were less emotionally involved in play. He suggested that

> . . . when the child is made consciously aware of the identification through "identification-stimulation" he tends to reject this behavior and . . . it then becomes associated with failure to lose inhibitions. . . . It is plausible that even spontaneously occurring identification, when recognized by S, would lead to inhibition on the theory that conscious identification increases the similarity between real social situations and fantasy doll situations; this would facilitate generalization of inhibition from social experiences to thematic play behavior. (1, p. 49.)

In the present study, specific identification with the self doll was not pressed. An indirect suggestion was made that the doll family was the same as that of the subject, and any identification was allowed to appear spontaneously. The criteria of identification were not as centered around the identification-doll as were those of Bach, but were enlarged to include identification with the family. Therefore, identification could be of the home-and-family-comparison kind as well as of the "I," "self-thematic," and role-taking kinds. The method of recording did not differentiate these types or indicate with whom or what the child identified.

Since the identification-stimulation was less intensive than that applied by Bach, and since the children were not under any compulsion to identify with the self doll or doll family, we should not expect to find the associated tendency to reject identification or for them to be greatly inhibited in their activity, even though aware of the resemblance to some extent. This may

account for the somewhat more individualized thematic play of the children who displayed identification in some way. Although total thematic aggression and nonstereotyped aggression did not differ significantly between identifiers and non-identifiers, the slight tendency for aggression to decrease within the identifying group as identification increased would be in line with Bach's theory. The wide variability of scores among the subjects, however, must be considered in this respect.

There was a general impression that the instances of identification in the DF and SF groups were of the same nature. References to personality or non-doll similarities and experiences at home in relation to the experimental materials or thematic play were on a more conscious, superficial, conversational level than on that of a deep anxiety-provoking quality of identification. Perhaps there is less anxiety when the child is able to use a whole family with which to identify than if urged to identify with one doll. Then again, in these presumably normal preschool children, anxiety may not have been a factor leading one way or another to identification, thematic play, or aggression. We have no way of determining the completeness of the identification; from a few instances we may not imply a total acceptance of "That's my family." The occurrence of identification was also inconsistent; it varied from one kind to another and was not always apparently present.

Although the amount and kind of aggression did not differ reliably with the experimental variables, the direction of thematic aggression showed interesting differences. No significant differences were observed between groups with regard to the agent of aggression. This research was conducted during the war and, in some cases, a child's father was in the service away from home, a fact which is noticeable under the DF condition. In the DF-No Sibling group, six children received the father doll and one child, a grandmother doll. In the DF-One Sibling group a baby doll was presented to the child whose sibling was under 18 months old. The size of the sibling doll varied in relation to the age of the child and that of his brother or sister. In this group three children were given the baby doll; 13 children, a sibling doll; 10 children, the father doll; two children, the grandmother doll; and one child, the grandfather doll. The groups, therefore, were not comparable as a whole, but were in part, all having available the self doll, fantastic agent, mother doll, family group, experimental materials, and the experimenter.

Reliable differences for object of aggression were found for the mother and self dolls. The significant predominance of aggression toward the self doll in the No Sibling group may be a

function of the small number of dolls presented to these children. There was a similar tendency for aggression toward the self doll to be greater in the DF than in the SF group. Levy (7) describes aggression toward the self doll as a form of "self-punishment or self-retaliatory hostility," which appeared as severe or as mild as the preceding hostility toward other dolls. The role of the self doll is not clear; few children in the present study consciously stated an identification with it.

In the DF groups there seemed to be a more selective concentration of aggression than in the SF groups. Significantly more aggression under the DF condition was directed toward the mother doll; the father doll in the DF-No Sibling group received large amounts of aggression. In the DF-One Sibling group it is interesting to note that the baby doll was the object of more aggression than was the doll representing an older sibling. Aggression in the SF groups was more evenly distributed among the categories than in the DF groups. Greater aggression in the DF group (particularly the DF-No Sibling group) toward the self doll, if a result of this localization of aggression, would support Levy's observation.

These results would suggest that, although presenting a set of dolls duplicating a child's family produces reliably no more difference in amount or kind of aggression than does a standard set of dolls, the way in which this aggression is distributed and directed under the DF condition may be of diagnostic significance in indicating areas of tension in the home situation. One would expect this to be more revealing in the case of individual children and in a clinical frame of reference.

In interpreting these results, however, the inequality of the groups of subjects and the number of dolls which they received must be taken into account, as well as the mixture of variables and the variability of aggression and identification scores. The children under the DF condition received an average of 3.4 dolls with which to play, while those under the SF condition were given five dolls. The DF-No Sibling group had an average of 2.8 dolls and the DF-One Sibling group, 3.8 dolls. Different numbers of children played with each doll. If relatively the same amount of aggression was shown by each group, that with fewer dolls would receive a larger proportion of aggression for each doll. A control experiment, in which the DF and SF groups contain children whose families are of the same size and in which the dolls are comparable for all groups, would throw light upon this question. A more generalized distribution of aggression in the SF group in relation to the amount of aggression toward the self doll and others in the DF group may, again, indicate the value of a duplication of family constellation

in doll play.

Conclusions

1. Under the DF condition, the frequency of identification signs was significantly higher at better than the one percent level of confidence than with the SF condition.

2. No significant differences in mean frequencies of the general behavior categories were found between the No Sibling and One Sibling groups or, with the exception of identification, between the DF and SF groups.

3. As an object of aggression, the self doll received significantly more thematic aggression in the No Sibling group than in the One Sibling group, and there was a similar tendency in the DF group. There was reliably greater thematic aggression toward the mother doll in the DF than in the SF group.

4. No reliable differences between groups appeared with regard to the agent of aggression.

5. A correlation ratio of -.50 (standard error ± .16) between identification and thematic aggression was obtained. There was a large variability in scores.

6. No significant differences in amount and kind of aggression were found between children who showed identification and those who did not.

7. There appeared to be a more selective concentration of aggression in the DF than in the SF groups, suggesting a diagnostic value in the use of a duplicated family constellation.

8. The inequality of groups of subjects and the number of dolls which they received, the mixture of variables, and the variability of scores must be considered in the interpretation of these results.

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SEXUAL MATURATION AND THE GROWTH OF FAT, MUSCLE AND BONE IN GIRLS

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In a previous paper (1), a method was described for comparing children in terms of the breadths of bone, muscle mass and superficial fat in the leg. Measurements of these three tissue components in this anatomical area were based on a longitudinal series of roentgenograms, taken specifically for the study of tissue differentiation. Growth changes, sex differences and individual variations in tissue distribution were discussed. It was also suggested that differential tissue distribution may be related to such characteristics as sexual maturation, and a preliminary report on this problem has been made (2).

The present paper is concerned with the relationship of breast development in girls to the growth of fat, muscle and bone in the leg. In broader terms it is thus a study of the relationships between sexual maturation and body structure, as they are reflected by a single maturational criterion and by the tissue distributions in a single body area. Although this report is concerned for the most part with girls between the ages of 7 1/2 and 12 1/2 years of age, certain observations on boys are included.

The children are all regular participants in the Fels Research Institute program, and include 48 girls and 30 boys, on whom a longitudinal series of 417 special sets of "soft-tissue" roentgenograms have been taken. The schedules and techniques for taking the roentgenograms, and the method of measuring tissue breadths from them, are discussed in the previous paper (1).[1]

[1] *"Soft-tissue" roentgenograms of eight representative areas of the body are taken annually on all Fels children, beginning at 6 ¼ years. The films are taken at a 6-foot focal-film distance, under standard conditions of positioning. Only the leg area is reported on in this paper. The breadths of fat (plus skin), bone (tibia plus fibula), and muscle mass (including lateral, medial and interosseous) are measured from the roentgenogram, at the position of greatest calf breadth. In the present study, the interosseous space, considered separately in the original paper (1), has been included as a part of muscle breadth. In this way, the breadths of fat, muscle and bone when totalled equal the calf*

Sexual Maturation

It is recognized that no single maturational criterion completely describes the process of maturation. Such criteria as menarche, skeletal development, endocrine status, growth rates, and various measurements and external features associated with maturation have been described in recent studies (3, 4, 5, 6, 7, 8, 9).

Serial observations of sexual maturation are made twice yearly on all Fels children, and are supplemented by inspection of nude photographs taken at that time. All the features mentioned above are recorded (10). One such characteristic is the age at bud-stage of breast development (11, 12), which is determined for each girl. This is a maturational feature which is relatively easy to identify; it appears early in the sequence of somatic changes accompanying pubescence, and shows certain associations with other maturational features.

The mean age at first appearance of breast buds in the 48 Fels girls studied is 10.7 ± 1.1 years, and the coefficient of correlation (r) between this characteristic and time of menarche in 27 girls is .894. The next definitive maturational item available, first appearance of pigmented pubic hair, has a mean of 11.2 ± 1.1 years for these same girls, and the r between this item and menarche is .637. The r between first sign of breast development and first appearance of pubic hair is .601. In 39 of the 48 girls, breast development appeared as soon as (11 cases) or prior to (28 cases) pubic hair.

In boys, the best available item appeared to be time of appearance of pigmented pubic hair, corresponding to item 3 in the listing of external changes associated with male sexual maturation, as described by Greulich, et al. (7). These boys would fall into maturity group 2-3 in their monograph.

Girls who showed breast development by 10 1/2 years of age were classed as "early-maturing," while those who showed no sign of breast development by this age were classed as "late-maturing." There were 24 girls in each category. Boys who showed pigmented pubic hair by 12 1/2 years (17 cases) were classed as "early-maturing," while boys who did not show this feature by this age were classed as "late-maturing" (13 cases). Although there seems good reason to believe that early appearance of these maturational items is related to early sexual maturation as a whole, the descriptive terms used are limited to their definition as given above.

breadth, and the relative breadths of fat, muscle and bone when totalled equal 100 percent.

Distributions of these cases, by maturity group, by age-level, and by number of annual x-rays taken on each child, are shown in Table 1.

TABLE 1

DISTRIBUTION OF CASES

(1) By Number of Annual X-rays per Child

	Boys				Girls		
No.	Early-Maturing	Late-Maturing	Total	No.	Early-Maturing	Late-Maturing	Total
3	0	0	0	3	1	0	1
4	1	1	2	4	5	4	9
5	6	4	10	5	11	9	20
6	9	8	17	6	6	9	15
7	1	0	1	7	1	2	3
	17	13	30		24	24	48

Total Number of Children: 78

(2) By Age

	Boys				Girls		
Age	Early-Maturing	Late-Maturing	Total	Age	Early-Maturing	Late-Maturing	Total
6.5	1	0	1	6.5	9	5	14
7.5	8	4	12	7.5	16	13	29
8.5	8	5	13	8.5	16	16	32
9.5	9	9	18	9.5	20	22	42
10.5	14	11	25	10.5	18	23	41
11.5	16	13	29	11.5	14	18	32
12.5	15	12	27	12.5	11	16	27
13.5	10	8	18	13.5	7	8	15
14.5	7	7	14	14.5	7	6	13
15.5	4	3	7	15.5	3	2	5
16.5	3	0	3	16.5	0	0	0
	95	72	167		121	129	250

Total Number of X-rays: 417

As shown in Table 1, most of the children (66 out of 78) have had five or more consecutive annual x-rays taken. For most comparisons, the period between 7 1/2 and 12 1/2 years will be considered.

Results

Height and Weight

Before considering the relationships of sexual maturation to the breadth of the calf, and to the breadths of fat, muscle and

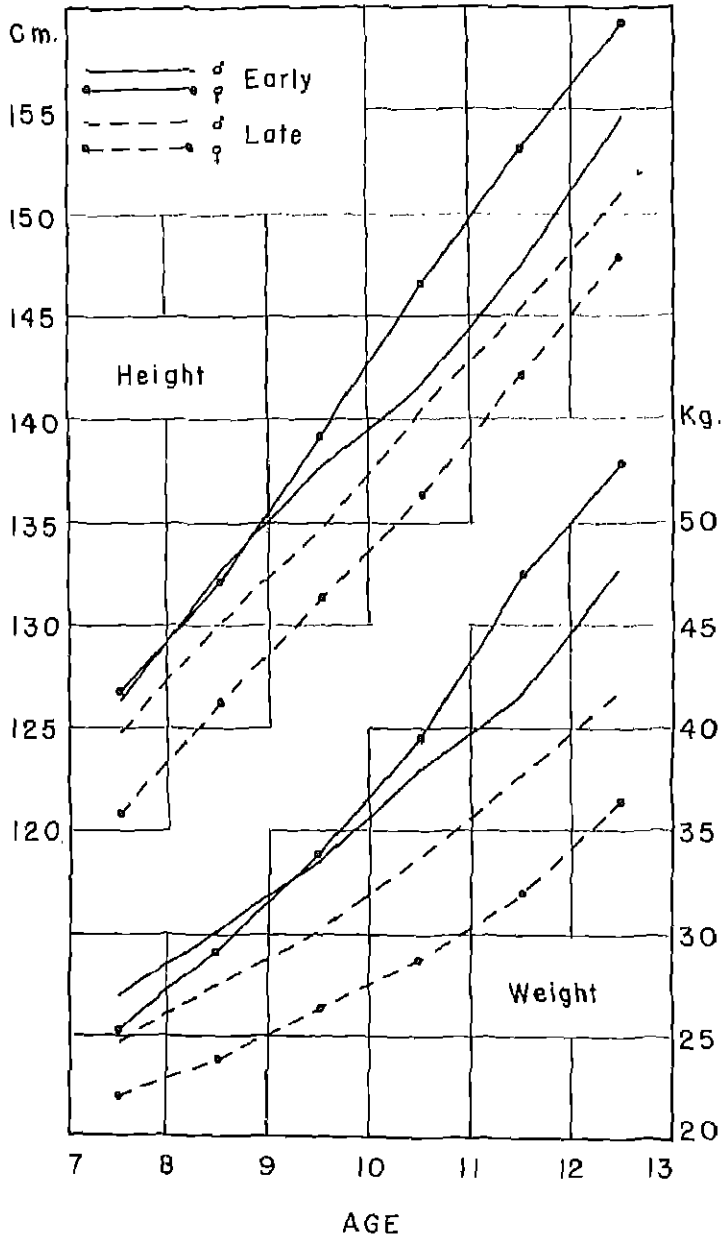

Figure 1. Means of heights and weights for early- and late-maturing girls and boys.

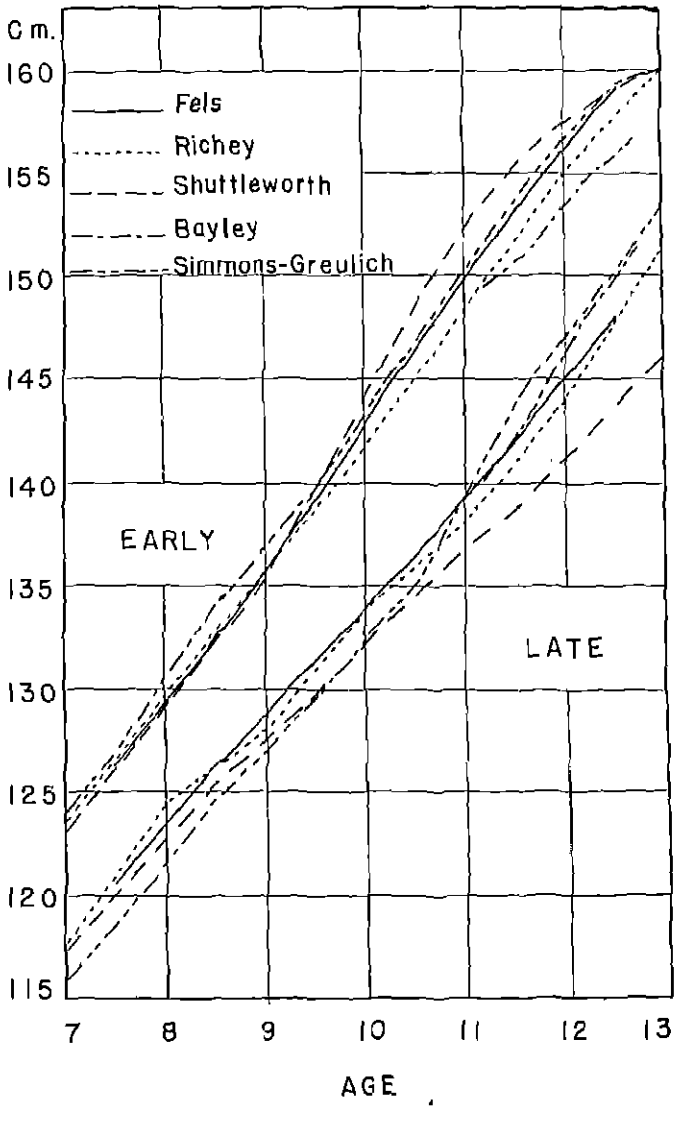

Figure 2. A comparison of mean heights for early- and late-maturing girls, based on five reports: Richey (3), Shuttleworth (6), Bayley (8), Simmons and Greulich (9), and the present study. Because of differences in group norms, all Shuttleworth values have been increased by 4 cm., and all Simmons and Greulich values decreased by 3 cm.

bone within the calf, a comparison was made of height and weight curves, for both early- and late-maturing groups of girls and boys. The results are shown in Figure 1.

In both height and weight, the mean values for early-maturing girls are not only larger than the means for late-maturing girls at every age-level considered, but they are also, after 9 1/2 years, larger than the means for either of the boys' maturity groups. Early-maturing boys are larger on the average than late-maturing boys of the same age, but the difference is much less pronounced than in the girls.

A number of other studies have compared the heights and weights of early- and late-maturing children, using various criteria of sexual maturation. Richey (3) used the time of appearance of axillary hair in boys and of menarche in girls. Shuttleworth (4, 5, 6) employed time of menarche in girls, and age at the close of the year of maximum growth in standing height (*MG*-age) for both boys and girls. Bayley (8) used skeletal maturation, based on Todd standards (13), in her study of the body build of adolescents. Simmons and Greulich (9) used both menarche and skeletal age in their study of the Brush Foundation series of girls. In Figure 2, the mean heights obtained in the present paper, using time of breast development as a criterion of sexual maturation, are compared with data from these four papers.

In spite of the variety of criteria employed for classifying maturity groups, and the varying number of maturity groups separated out in the several studies, the mean heights within each maturity group show a reasonable correspondence in all five studies. In the Shuttleworth series, the early-maturing girls tend to be taller, and the late-maturing girls shorter, than in the Fels series. This could be expected, since Shuttleworth used a nine-fold maturity classification for girls, and the curves here plotted represent the extremes. Richey, Bayley, and Simmons and Greulich used three-fold classifications.

Similar comparisons for girls' weight, and for height and weight in boys, present much the same picture, and are not shown here.

Norms for Early- and Late-Maturing Girls

Tables 2, 3, 4 and 5 compare early- and late-maturing girls in terms of total breadth of calf, and breadths of fat, muscle and bone within the calf. Means, standard deviations and coefficients of variation are shown. Figure 3 presents the means in graphic form.

The greater mean breadth of the calf in the early-maturing group is apparent at every age-level studied, as shown in Figure

TABLE 2

TOTAL BREADTH OF CALF (mm.)

Early-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	14	82.6	6.4	7.7
8.5 Years	14	87.3	6.3	7.2
9.5 Years	18	91.0	7.6	8.4
10.5 Years	18	97.2	7.3	7.6
11.5 Years	14	103.9	10.2	9.8
12.5 Years	11	109.1	11.0	10.0

Late-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	12	79.3	6.2	7.8
8.5 Years	15	80.9	5.8	7.2
9.5 Years	21	83.3	6.4	7.7
10.5 Years	23	85.9	6.4	7.4
11.5 Years	18	88.8	8.0	9.0
12.5 Years	16	91.2	6.4	7.0

TABLE 3

BREADTH OF FAT (mm.)

Early-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	14	14.5	2.6	18.1
8.5 Years	14	15.0	3.0	20.3
9.5 Years	18	15.6	3.3	21.1
10.5 Years	18	16.0	2.8	17.7
11.5 Years	14	18.1	2.6	14.2
12.5 Years	11	19.2	2.4	12.7

Late-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	12	11.6	3.6	31.5
8.5 Years	15	12.1	3.5	28.9
9.5 Years	21	12.2	3.1	25.5
10.5 Years	23	13.0	3.1	24.2
11.5 Years	18	13.4	4.0	30.1
12.5 Years	16	13.3	3.4	25.2

TABLE 4

BREADTH OF MUSCLE MASS (mm.)

Early-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	14	42.8	6.1	14.2
8.5 Years	14	46.0	5.9	12.8
9.5 Years	10	48.0	6.6	13.7
10.5 Years	18	52.0	5.8	11.1
11.5 Years	14	54.5	7.4	13.5
12.5 Years	11	58.0	8.6	14.9

Late-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	12	43.6	4.3	9.8
8.5 Years	15	44.4	4.0	8.9
9.5 Years	21	45.5	4.5	9.9
10.5 Years	23	46.2	4.4	9.5
11.5 Years	18	47.3	5.1	10.9
12.5 Years	16	49.3	4.9	9.9

TABLE 5

BREADTH OF BONE (mm.)

Early-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	14	25.4	1.3	5.2
8.5 Years	14	26.3	1.4	5.2
9.5 Years	18	27.4	1.5	5.5
10.5 Years	18	29.2	1.9	6.6
11.5 Years	14	31.3	2.0	6.3
12.5 Years	11	32.0	2.0	6.2

Late-Maturing Girls

Age	No.	Mean	S. D.	C. V. (%)
7.5 Years	12	24.1	2.2	9.0
8.5 Years	15	24.4	2.0	8.0
9.5 Years	21	25.6	1.9	7.5
10.5 Years	23	26.7	2.4	9.1
11.5 Years	18	28.1	2.7	9.6
12.5 Years	16	28.6	2.5	8.8

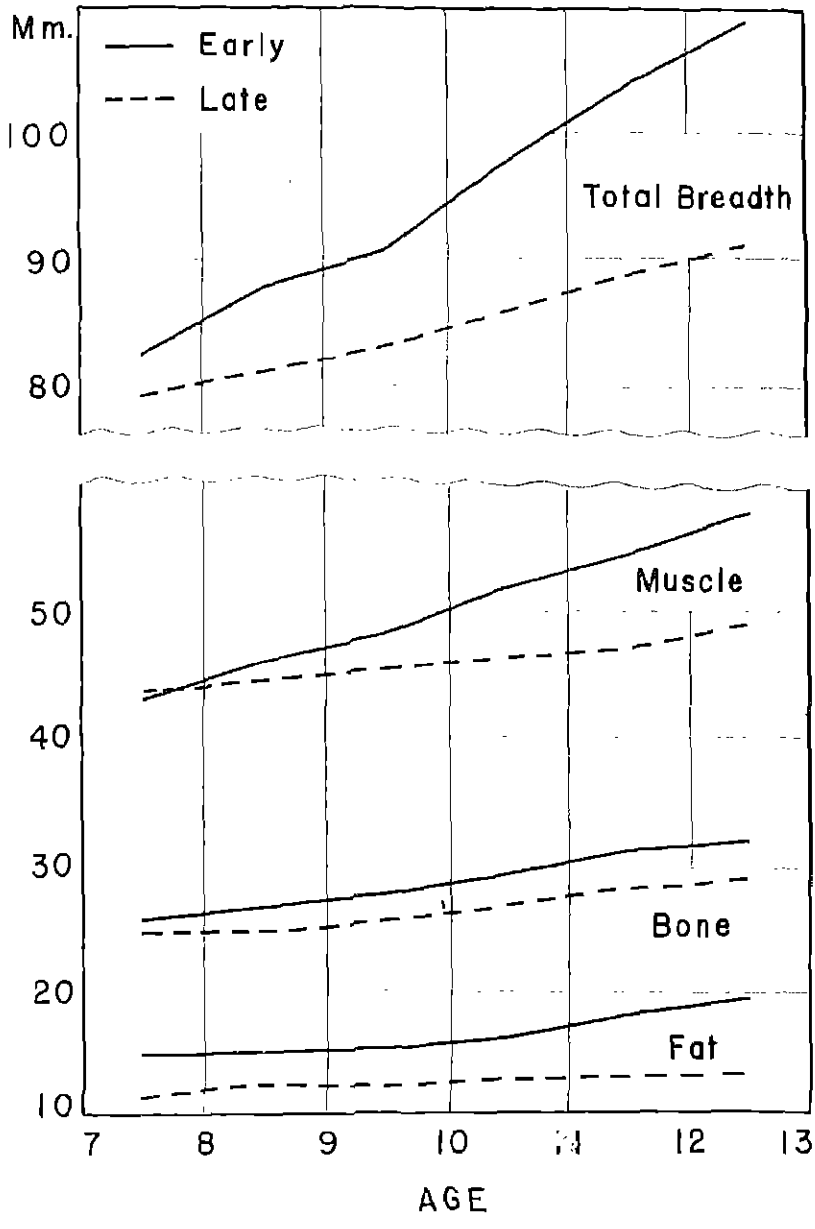

Figure 3. Means of total breadth of calf, and of fat, muscle and bone breadths within the calf, for early- and late-maturing girls.

3; early-maturing girls are on the average about 3 mm. larger at 7 1/2 years, and increase this difference to 18 mm. at 12 1/2 years. In individual tissue breadths, early-maturing girls are larger in every characteristic except mean muscle breadth at 7 1/2 years.

At the 5 percent level of significance, early-maturing girls are significantly larger as follows: total calf breadth, 8 1/2 through 12 1/2 years; breadth of fat, all ages; breadth of muscle, 10 1/2 through 12 1/2; breadth of bone, 8 1/2 through 12 1/2.

Growth Rates

The shifts in differential tissue patterns can be shown more meaningfully by considering growth rates (Table 6), than by comparing absolute values.

TABLE 6

RATES OF INCREASE IN CALF BREADTH AND TISSUE BREADTHS, BETWEEN 7 1/2 AND 12 1/2 YEARS

Early-Maturing Girls

	Total Breadth of Calf	Breadth of Fat	Breadth of Muscle	Breadth of Bone
Mean Value at 12 1/2 Years (mm.)	109.1	19.2	58.0	32.0
Mean Value at 7 1/2 Years (mm.)	82.6	14.5	42.8	25.4
Gain (mm.)	26.5	4.7 (18%)	15.2 (57%)	6.6 (25%)
Rate of Gain (%)	32.1	32.6	35.6	26.0

Late-Maturing Girls

	Total Breadth of Calf	Breadth of Fat	Breadth of Muscle	Breadth of Bone
Mean Value at 12 1/2 Years (mm.)	91.2	13.3	49.3	28.6
Mean Value at 7 1/2 Years (mm.)	79.3	11.6	43.6	24.1
Gain (mm.)	11.9	1.7 (14%)	5.7 (48%)	4.5 (38%)
Rate of Gain (%)	15.0	14.9	13.0	18.7

When rates of increase in size are considered, early-maturing girls show a rate of gain of 32.1 percent in total breadth of calf, for the 5-year period between 7 1/2 and 12 1/2 years.

During this same age-period, late-maturing girls show a rate of gain of only 15.0 percent. These differences also show in the growth rates of the individual tissues within each maturity group. Early-maturing girls have a rate of gain for mean breadth of fat of 32.6 percent, for mean muscle breadth 35.6 percent, and for mean bone breadth 26.0 percent. In late-maturing girls, the rate of gain for mean fat breadth is 14.9 percent, for mean muscle breadth 13.0 percent, and for mean bone breadth 18.7 percent.

Considered in another way (Table 6), early-maturing girls during this period show a mean increase in total breadth of calf of 26.5 mm., of which fat, muscle and bone breadths contribute percentages of 18, 57 and 25, respectively. Late-maturing girls, on the other hand, during this same period, show a total increase of only 11.9 mm., of which fat, muscle and bone breadths contribute percentages of 14, 48 and 38, respectively.

In summary, early-maturing girls are larger in the absolute size of the calf breadth and of the three component tissues, between 7 1/2 and 12 1/2 years of age. They also show a higher rate of gain, both for total calf breadth, and for each of the three tissue breadths. Finally, in the early-maturing group, the growth rate for muscle breadth is higher than for total breadth of calf, while the growth rate for bone breadth is lower. In the late-maturing group, this picture is reversed: the growth rate for muscle breadth is lower than for total breadth of calf, while the growth rate for bone breadth is higher.

TABLE 7

RELATIVE BREADTHS OF FAT, MUSCLE AND BONE, AT 7 1/2 AND 12 1/2 YEARS

7 1/2 Years

Group	Relative Fat (Percent)	Relative Muscle (Percent)	Relative Bone (Percent)
Early-Maturing Girls	16.1	53.3	30.6
Late-Maturing Girls	17.6	51.6	30.8
	14.3	55.2	30.4

12 1/2 Years

Group	Relative Fat (Percent)	Relative Muscle (Percent)	Relative Bone (Percent)
Early-Maturing Girls	16.2	53.5	30.3
Late-Maturing Girls	17.4	52.9	29.6
	14.6	54.1	31.3

Relative Breadths

Norms for the relative breadths of the three tissue components (individual tissue breadths expressed as a percentage of total breadth) have been calculated for early- and late-maturing girls. They will not be presented here in detail, but their pattern is clear, and the results at 7 1/2 and 12 1/2 years are shown in Table 7.

At both age-levels shown in Table 7 (and at all intervening ages as well), early-maturing girls show a relatively greater mean fat breadth, and a relatively smaller mean muscle breadth. There is little difference between the two groups in mean relative bone breadth at 7 1/2 years, but by 12 1/2 years early-maturing girls are relatively smaller. It may be noted that the group norms for the mean relative breadths of the three tissues shift very little between 7 1/2 and 12 1/2 years, remaining close to 16 percent for fat, 53 percent for muscle, and 30 percent for bone.

Coefficients of Variation

Certain differences between early- and late-maturing girls may be shown by an examination of the coefficients of variation in Tables 2-5. Early-maturing girls tend to be slightly more variable in total calf breadth. However, differences are more clearly shown in the values for the individual tissue breadths. Early-maturing girls are more variable in breadth of muscle during this period, and late-maturing girls more variable in breadths of fat and bone. As in the group values discussed in the previous paper (1), breadth of fat is in general the most variable item, and breadth of bone the least.

Correlations

In Table 8, certain relationships between time of breast development and the growth of the calf are examined, by means of the coefficient of correlation.

Zero-order coefficients of correlation show an increasingly close relationship between early breast development and greater breadth of individual tissue components, at succeeding age-levels. The values show the same patterns for fat and bone breadths, increasing from -.27 to -.76 for fat, and from -.34 to -.65 for bone. Muscle breadth shows little relationship to time of breast development at earlier age-levels, but increases to -.63 at 12 1/2 years. The r between time of breast development and total calf breadth shows a steady rise from -.22 to -.81.

The following coefficients show statistical significance at the 5 percent level: time of breast development with total calf

TABLE 6

COEFFICIENTS OF CORRELATION, GIRLS

Zero Order

Item	Age 7 1/2	8 1/2	9 1/2	10 1/2	11 1/2	12 1/2
Time of Breast Development and Total Breadth of Calf	-.22	-.44	-.50	-.64	-.72	-.81
Time of Breast Development and Breadth of Fat	-.27	-.29	-.41	-.46	-.64	-.76
Time of Breast Development and Breadth of Muscle	+.05	-.21	-.25	-.49	-.52	-.63
Time of Breast Development and Breadth of Bone	-.34	-.52	-.50	-.53	-.63	-.65
Breadth of Fat and Breadth of Muscle	-.14	.00	+.21	+.39	+.57	+.59
Breadth of Fat and Breadth of Bone	+.50	+.53	+.48	+.51	+.62	+.55
Breadth of Muscle and Breadth of Bone	-.17	-.03	-.01	+.15	+.31	+.26

Second Order

Item	7 1/2	8 1/2	9 1/2	10 1/2	11 1/2	12 1/2
Time of Breast Development and Breadth of Fat	-.10	-.02	-.16	-.11	-.24	-.44
Time of Breast Development and Breadth of Muscle	-.01	-.26	-.25	-.44	-.30	-.43
Time of Breast Development and Breadth of Bone	-.24	-.47	-.41	-.44	-.42	-.49
Number of Cases	29	32	42	41	32	27

breadth, 8 1/2 through 12 1/2 years; with fat breadth, 9 1/2 through 12 1/2; with muscle breadth, 10 1/2 through 12 1/2; and with bone breadth 8 1/2 through 12 1/2.

When the above values are corrected for the intercorrelations between the three tissue components, the second-order partial coefficients show the same tendency to increase with age. However, the values are in general lower, and the relationships shift somewhat. The partial r between time of breast development and fat breadth remains low until 12 1/2 years, when it becomes significant at -.44. The coefficient for time of

breast development and muscle breadth rises from near zero to the forties, being significant at 10 1/2 and 12 1/2 years. The value for time of breast development and bone breadth remains, after 7 1/2 years, consistently in the forties, and is statistically significant.

The multiple R for time of breast development and the three tissue breadths parallels the zero-order r of time of breast development and total calf breadth, rising from .35 at 7 1/2 to .65 at 12 1/2 years.

A Longitudinal Comparison of Early- and Late-Maturing Girls, Matched for Total Breadth of Calf at 7 1/2 Years

In the preceding sections, comparisons have been made of early- and late-maturing girls by a consideration of values which are partly cross-sectional, partly longitudinal in nature. This is because of the presence of some but not all of the same cases at adjacent age-levels, a "shingle-like" effect which is a common situation in longitudinal studies of human development. In the present section, a strictly longitudinal approach is made, in that the same girls are represented at four successive age-levels. In addition, the two groups are matched for mean size of calf at 7 1/2 years. This was done by ranking the values for total breadth of calf in each maturity group, and successively eliminating the largest early-maturing girls, and the smallest late-maturing girls, until the mean values for the latter group exceeded the former. Ten girls of each group were thus obtained, and their mean values, for all four tissue variables, between the ages of 7 1/2 and 10 1/2 years, are shown in Figure 4.

The ten girls of each maturity group, whose means are compared in Figure 4, thus represent the ten smallest early-maturing girls and the ten largest late-maturing girls, in size of calf at 7 1/2 years. As can be seen, the matching of the two groups in mean calf size reflects only the larger muscle breadths, at this age-level, of the late-maturing girls. In spite of being smaller in mean calf breadth, the early-maturing group is larger in mean fat and bone breadths, and maintains this size superiority through 10 1/2 years. In muscle breadth, the early-maturing girls overcome the early size handicap, and by 10 1/2 years are also larger than late-maturing girls in this characteristic, and of course in total breadth of calf as well.

An additional small series of five cases in each maturity group was treated in the same manner at 10 1/2 years, and followed through 12 1/2 years. The results may also be seen in Figure 4. Much the same pattern is shown, except that fat breadth in the early-maturing group is slightly smaller at 10 1/2 years, and remains smaller during the next two years.

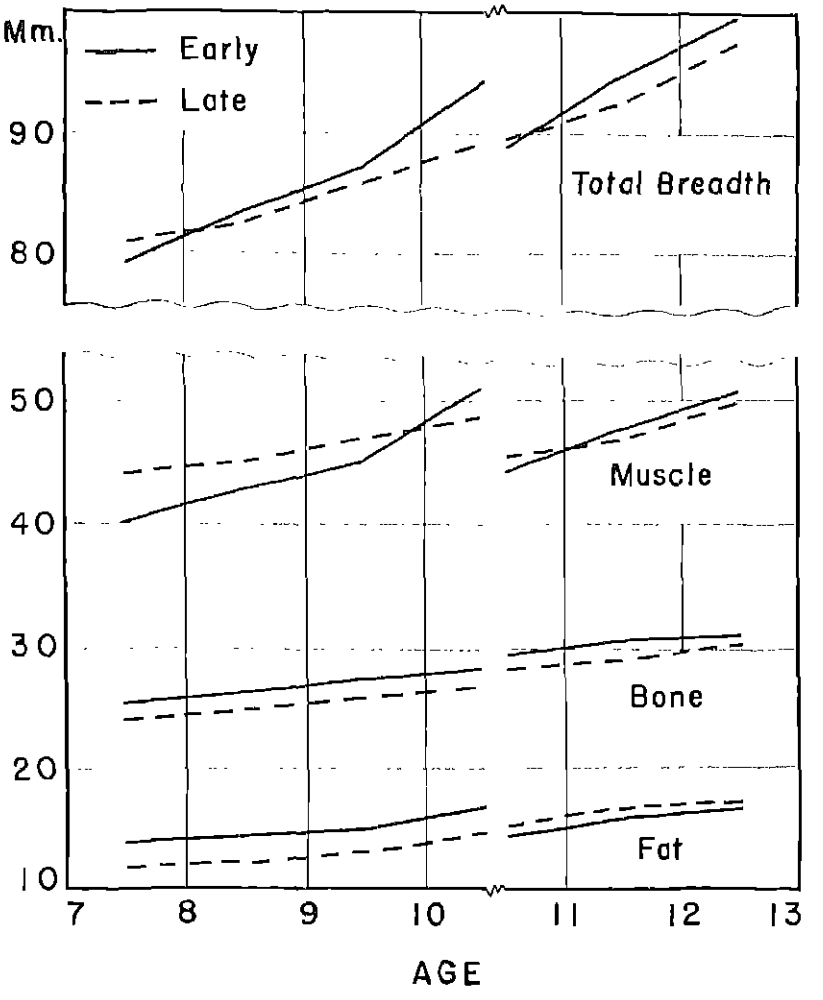

Figure 4. A comparison of mean tissue breadths for early- and late-maturing girls, based on the selection of the ten smallest early-maturing girls at 7 1/2 years, and the ten largest late-maturing girls at the same age. These two groups are followed through 10 1/2 years, when another selection of 6 girls in each maturity group is made, and followed through 12 1/2 years.

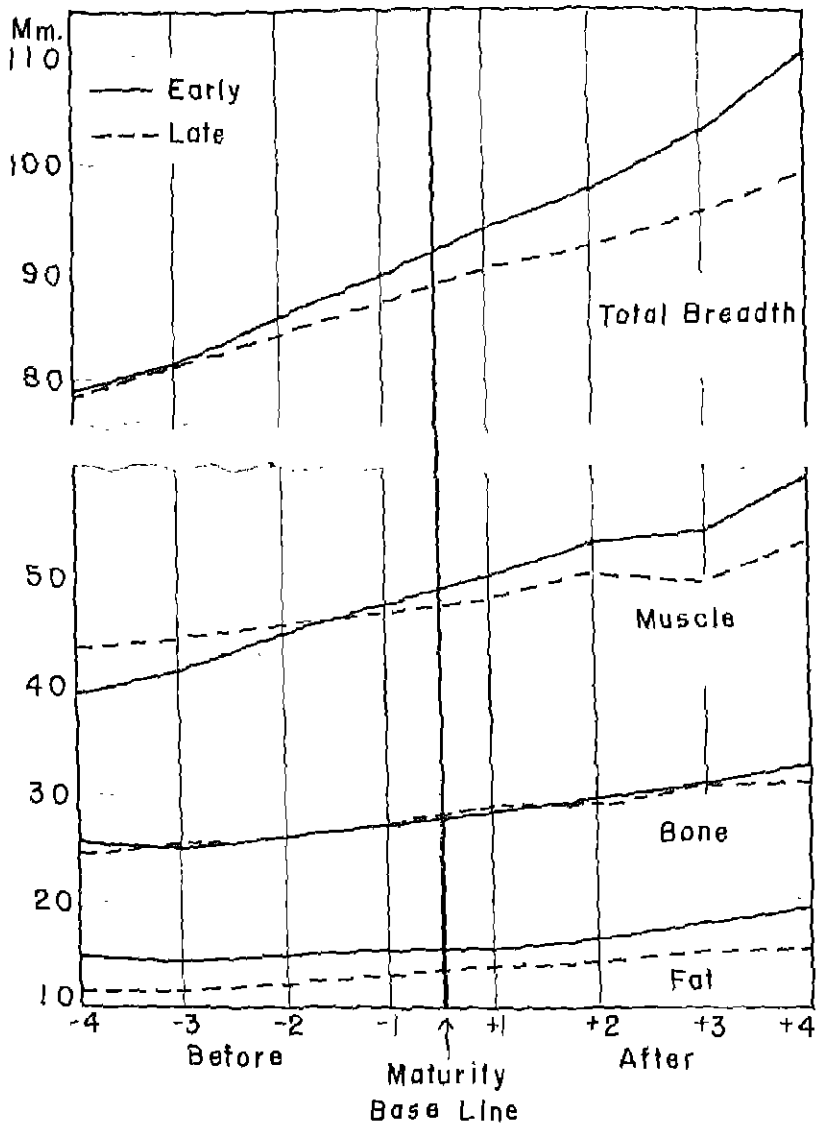

Figure 5. A comparison of mean tissue breadths for early- and late-maturing girls, arranged so that individual ages at first appearance of breast-buds fall on the maturity base-line. See text.

A Comparison of Early- and Late-Maturing Girls, using Time of Breast Development as a Base-Line

In Figure 5, early- and late-maturing girls are compared by a method which in part relates patterns of tissue growth to sexual maturation, rather than to chronological age.

The captions "before" and "after" in Figure 5 refer to the sequence of annual x-rays, taken each half-birthday, as related to each girl's age at first appearance of breast development. Thus, if a girl's maturity age is 11 years, -1 refers to her individual tissue breadths at 10 1/2 years, while -2 refers to her measurements at 9 1/2 years, and so on. In like manner, +1 refers to her measurements at 11 1/2 years, +2 to her measurements at 12 1/2 years, and so on. In this way, patterns of tissue breadths are equated to time of breast development, and the mean values for all girls at the same chronological distance from individual times of breast development are compared.

There is practically no difference between the two maturity groups in mean total breadth of calf, for the -4 and the -3 measuring periods. That is, early-maturing girls, at 3 1/2 years and at 2 1/2 years before age at first breast development, are no larger on the average than late-maturing girls at comparable periods. However, beginning at about 1 1/2 years before time of breast development (-2 period), and continuing through the maturity base-line and four measuring periods beyond, early-maturing girls progressively widen the size difference between themselves and late-maturing girls.

This simple pattern of a gradually widening difference between the larger early-maturing girls and the smaller late-maturing girls corresponds to the familiar picture shown by weight and height, and by over-all, external measurements of body size. However, when the patterns for fat, muscle and bone breadths are compared by the same method, each tissue component appears to behave in a distinctive fashion. With time of breast development held constant, the two maturity groups cannot be clearly distinguished by mean breadth of bone. In mean breadth of fat, early-maturing girls remain consistently larger, both before and after time of breast development. In mean breadth of muscle, early-maturing girls are distinctly smaller before time of breast development, but increase much more rapidly, passing the late-maturing group near the -1 period, and continue their rapid progress to become distinctly larger by the +4 period.

The gradually widening differences in total calf breadth between early- and late-maturing girls appears, therefore, to be a resultant of three quite different patterns of growth in the breadths of the fat, muscle and bone within the calf.

Early- and Late-Maturing Boys

Problems of considerable interest and importance lie in the study of sex-differences in growth during the period of sexual maturation. These problems go beyond the size differences which are associated directly with earlier sexual maturation in girls. In terms of the present study, such questions as these arise: When sexual maturation is equated for the sexes, what general sex differences exist in the growth patterns for fat, muscle and bone breadths? How do the differences in tissue patterns between early- and late-maturing boys compare with the differences in tissue patterns between early- and late-maturing girls?

Sufficient data have not been collected to attempt to answer such questions. However, certain observations on boys are presented in this section, based on the small number of cases (17 early-maturing and 13 late-maturing boys) so far available.

Comparisons of early- and late-maturing boys by height and weight have already been discussed. Early-maturing boys are larger than late-maturing boys in both mean height and mean weight, at each age-level studied, but the differences are less pronounced than in the girls.

Early-maturing boys are larger than late-maturing boys in mean breadths of the calf, and of fat, muscle and bone within the calf, at each age-level between 9 1/2 and 12 1/2 years. The differences, however, are not as great as in the girls. Also, the mean relative fat breadths for early-maturing boys are larger, and the mean relative breadths for muscle and bone are smaller, than in late-maturing boys; a similar comparison holds for the girls.

The growth rate for total breadth of calf in early-maturing boys, between the ages of 9 1/2 and 12 1/2, is 14 percent; in late-maturing boys the rate is 15 percent. This is quite different from the comparison of early- and late-maturing girls during the same age-period: early-maturing girls gain 18 percent during these three years, and late-maturing girls only 8 percent. Other sex differences show in the comparison of the rates for individual tissues. Early-maturing boys gain 19.5 mm. in total calf breadth during these three years. Of this gain, fat, muscle and bone breadths contribute percentages of 8, 54 and 38, respectively. Late-maturing boys, during this same period, gain 20.6 mm., of which fat, muscle and bone breadths contribute percentages of 22, 48 and 30, respectively. The main differential in boys, therefore, appears to be the faster rate of growth in fat breadth in late-maturing boys. These comparisons refer, of course, only to the period between 9 1/2 and 12 1/2 years.

When early- and late-maturing boys are matched for size of calf at 10 1/2 years, and a subsequent longitudinal comparison made, the differences which characterized the girls' groups appear at a somewhat later age. The chief difference between early- and late-maturing boys, between 10 1/2 and 13 1/2, lies in the greater fat breadth of early-maturing boys. Between 13 1/2 and 15 1/2, the rapidly increasing breadth of muscle, together with the consistently greater breadth of fat and bone, distinguishes the early-maturing group.

When early- and late-maturing boys are compared by using time of first appearance of pigmented pubic hair as a maturity base-line, the differences observed in the girls' groups are not fully apparent until the +3 period. Breadth of fat, however, is consistently larger in early-maturing boys at every period.

In summary, early-maturing boys are larger than late-maturing boys in total breadth of calf, and in the breadths of the three component tissues, at every age-level between 9 1/2 and 12 1/2 years. They show relatively greater fat breadths, and relatively smaller muscle and bone breadths. They do not show the faster rate of growth which is characteristic of early-maturing girls during this chronological period. When matched for size of calf at 10 1/2 years, and then followed longitudinally, early-maturing boys show the pattern (already described for the girls) of a rapidly increasing breadth of muscle, together with a consistently greater breadth of fat and bone, although less well defined, and at a considerably later age-level. When equated for time of appearance of pigmented pubic hair, the distinctive individual patterns of tissue breadths already described for the girls tend to appear also for the boys, but at a later time. In breadth of fat, however, early-maturing boys (as is the case in the girls) are consistently larger than late-maturing boys.

Discussion

A major purpose of the present paper has been to test whether simple measurements of tissue breadths in one anatomic area are sufficiently sensitive to be used as tools in the study of human growth. For this purpose, sexual maturation was chosen as a process known to be associated with rapid increase in body size, and the differential patterns of fat, muscle and bone breadths in the calf were studied in relation to this feature. Sexual maturation was defined in terms of breast development, since that is a characteristic which is easy to identify, and appears early and regularly in the sequence of somatic changes accompanying pubescence.

Such an investigation, based on measurements taken in a single anatomic area, and considering a process identified by a single criterion, is necessarily exploratory. Even at this preliminary stage, however, certain statements seem justified. First, external dimensions and total body weight give no reliable indications of the distribution of tissue components within the body. As demonstrated in a previous paper, two children may be matched for age, sex, height, weight, external calf dimensions and tibia length, and yet show clear-cut differences in the distribution of fat, muscle and bone within the calf.

Second, from the above it follows that a growth curve based on external dimensions or total mass, although it offers valuable information for other purposes, does not show the changing relationships of its tissue components. In this connection, Weinbach (14) says:

> "The growth of man, as a multi-cellular organism, is the sum of the growth of all the individual cells or groups of cells (tissues) of which the organism is composed. Considering the human body to be made up of tissues which obey one or the other of the two preceding types of growth, i.e., self-accelerating growth or self-inhibiting growth . . . X-ray studies of the growth of muscle and fat on the forearm indicate that the fat follows closely the decelerating law of growth, while the muscle is of the accelerating type." (pp. 236, 244.)

The fact that the various tissues have their individual patterns of growth has been discussed and illustrated in a number of studies, notably in the well-known work of Scammon, as reported in Harris, et al. (15). More recently, Jacoby (16) has studied changes in area as seen in cross-sections of cadaver material, while Wilmer (17) has reported on distribution by weight of several body components in fetal life, at birth, and in maturity. Stuart, et al. (18) has written several papers based on linear and areal examination of x-ray material.

Third, it must be emphasized that the breadth measurements discussed in this paper are concerned with only one dimension of the tissue masses as seen in the x-ray, and must be interpreted in this way. These measurements are closely related to tissue mass, but do not completely describe changes in structure, any more than an increase in total height need necessarily involve a change in total weight. Tissue breadths are one way of describing body structure, and are subject to the limitations of any linear measurements of bulk. Their particular value lies in the fact that they make possible certain comparisons of

t available from external measurements or

vious that an increase of a millimeter in bone
ivalent to an increase of a millimeter in fat
it affects body weight or volume, or in terms
l physiological relations within the organism.
.son, however, a child who shows an increase
bone breadth is a different kind of child from
i increase of a millimeter in fat breadth. A
:issue breadths of 11, 59 and 30 percentages
id bone is a different kind of child from one
of 24, 42 and 34 percentages for these three
though their external dimensions may be
·e, although the exact meaning of such differ-
be clear, nor the explanation for differential
it fully understood, the demonstration of such
ue growth appears to be justified.
iemistry program now under way at the Fels
iat promise of providing measures which will
ifferences in tissue distribution much more
rogram at present includes an intensive study
is, endocrine function and tissue metabolism,
rough measurements of vitamin excretion
oad tests, serum proteins, ketosteriod and
on and excretion, creatine-creatinine metab-
nzyme levels (19). The relationship of differ-
wth to fundamental metabolic processes, as
h biochemical measures, will be examined in
s.

MMARY AND CONCLUSIONS

oncerned with the problem of the relationship
.ion in girls to the growth of individual tissue
body. As an approach to this problem, a re-
n of the relationship of one aspect of sexual
of breast development) to the changing patterns
i of fat, muscle and bone breadths in one an-
leg).
ations on boys, using the appearance of pig-
as a maturity criterion, are also included.
n this study, 48 girls and 30 boys between the
16 1/2 years, are regular participants in the
stitute program. The data on sexual matur-
id from semi-annual examinations and from
:aken at this time. The data on body structure

are obtained from records of height and weight, and from 417 serial roentgenograms, taken specifically for the study of tissue differentiation.

The conclusions may be summarized as follows:

1. Early-maturing girls are larger than late-maturing girls in mean height and weight, at every age-level between 7 1/2 and 12 1/2 years. After 9 1/2 years, they are also larger than the means for either of the boys' maturity groups. These results are compared with the reports from four other investigations of the relationship of weight and height to sexual maturation.

2. Early-maturing girls are larger than late-maturing girls in total breadth of calf, and in the breadths of fat, muscle and bone within the calf, at every age-level studied. The significance of these differences is presented. The differences in boys are in the same direction, but to a lesser degree.

3. Early-maturing girls show a distinctly higher rate of gain in total breadth of calf, and in the breadths of the three tissue components, than do late-maturing girls. Boys do not show this difference in rates, during the age-range studied.

4. Early-maturing girls show a growth rate for muscle breadth which is higher than for total breadth of calf, and a growth rate for bone breadth which is lower. In late-maturing girls, the growth rate for muscle breadth is lower than for total breadth of calf, while the growth rate for bone breadth is higher.

5. Early-maturing girls, during this period, show a greater mean relative breadth of fat, and a smaller mean relative breadth of muscle and of bone, than do late-maturing girls. The same pattern holds for boys.

6. Early-maturing girls tend to be more variable in total calf breadth, and in muscle breadth, and less variable in breadths of fat and of bone, than do late-maturing girls.

7. Coefficients of correlation indicate an increasingly close relationship between early breast development and greater breadths of individual tissue components, at succeeding age-levels between 7 1/2 and 12 1/2 years. In addition to this general pattern, coefficients relating time of breast development to each of the three tissue components, when corrected for intercorrelations between the components, show certain individual patterns of relationship.

8. Results are given of a longitudinal comparison of early- and late-maturing girls, matched for mean size of calf at 7 1/2 years. Differential patterns of tissue distribution are discussed. Results of a similar comparison for boys are presented.

9. Results are given of a comparison of early- and late-

maturing girls, with patterns of tissue growth corrected for individual differences in sexual maturity. The simple pattern of a gradually widening difference in total calf breadth between early- and late-maturing girls, when observed in this fashion, appears to be a resultant of three quite different patterns of growth in the breadths of fat, muscle and bone within the calf. Results of a similar comparison for boys are presented.

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THE SPEECH BEHAVIOUR OF INFANTS WITHOUT FAMILIES

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The research on infant speech has until recently been mainly concerned with technical problems of measurement and with the establishment of normative sequences of speech development for the young child. As a clinical instrument these norms look extremely promising; they offer standardizations obtained from a large number of cases on the basis of which one may measure deviations in a manner similar to that used in intelligence testing (1).

Interest in this research area has gradually been shifting, however, in another direction. While these norms undoubtedly will offer a basis on which one may objectively determine the speech status of any individual child with respect to the sampled population, they tell us little by themselves about the relevant variables which have contributed to the status. Nor do they, therefore, tell us anything about the possibility or desirability of changing a specific individual's status. If such variables could be isolated we might achieve theoretical knowledge, as well as a diagnostic measure, of language acquisition during the earliest stages of the life history and its relation to the later acquisition of more complex symbolic habits.

If we started with children who diverged markedly from the speech norms established by recent investigators, it is quite possible that common causal factors in their environment contributing to the deviations could be discovered. If such factors could be found, they might be varied in a reasonably controlled situation, so as to experimentally weight their differential influence. Such a program would be costly and tedious to realize, however, and probably would have to be done through amorphous clinical channels. If, on the other hand, we could find homogeneous populations which differed as a group with the norms established thus far, research would not be so technically encumbered. We have a technique that meets these requirements in what the anthropologists call "cross-cultural comparisons."

Now, one of the basic criteria used by the anthropologists to distinguish cultures is the structure of the family group, broadly conceived. It is predominantly within this institution, under the guidance of parents as cultural surrogates, that the individual learns a complex set of responses which carry over into interactions with more formally organized institutions. Any difference in the character of the family structure and/or its cultural

surrogates would presumably affect the learning process itself, through both the administration and types of rewards and punishments used. This, in turn, would influence the character of the manifest cultural responses.

It is obvious that speech sounds function both as social responses and as social stimuli. The unpatterned speech of the infant is frequently a response to the behaviour of the members of the family, and in turn its speech sounds stimulate them to respond with culturally determined rewards and punishments. It is in these combined ways that infant speech acquires cultural meaning. When, as in this study, we compare orphanage infants with family infant groups, it is obvious that there are present wide differences with respect to family organization, cultural surrogates, and consequently the learning process itself. The presence of these conditions permits us to view our study on infant speech behaviour as a quasi-anthropological type of research.

Since this is the first systematic work, as far as we know, on the speech behaviour of orphanage infants at so early an age, its rather introductory nature should be emphasized. It is, of course, a general observation that children who grow up in the ordinary orphanage home are somewhat retarded in their speech development. Our study opens up the problem during the very earliest months of the orphanage child.

Procedure

The orphanage subjects of this study were 94 infants whose ages ranged from birth to six months of age. These subjects were residents of the Iowa Soldiers Home at Davenport, Iowa. They were divided into three age groups - from birth to two months, two to four months, and four to six months of age. There were 35 subjects in the first group, 33 in the second, and 26 in the third group. The subjects were classified as "dependent or neglected" children, the criterion of which is either 1) being destitute, homeless or abandoned or otherwise dependent on the public for support or 2) living in unfit surroundings, of either a physical or moral character or both. Feeble-minded children are not accepted at the Davenport orphanage and are transferred by the Iowa State Board of Control if so diagnosed.

The speech sound measurements of these orphanage children were then compared with measurements obtained from family infants living in Iowa City, grouped in the same way according to age, and containing 62, 80 and 75 babies in the successive age level periods.

A competent nurse of long experience in the institution was in charge of the babies and a physician is attached to the staff.

The day-to-day work of caring for the infants is done by hired, non-professional, female workers who are drawn mainly from the lower socio-economic level of the community. There is a large turnover among these employees. In addition, these women are usually assisted by several older orphanage girls. Thus, the bulk of the personnel, with the exception of the nurse and physician, are of quite elementary education, trained to carry on the simpler techniques of caring for the babies and *not at all motivated by strong personal interest or responsibility.*

In regard to the handling of the infants, all of them are bottle-fed and all receive satisfactory care so far as their physical needs are concerned. Excellent medical attention is provided. There is, however, little personal attention in the way of being held, played with or spoken to, except incidentally and sporadically.

The actual recording of sounds followed a definite procedure. While the infants lay asleep in their bassinets the observer recorded the name, sex, birth date, and recording date on a card, which was then left in the crib. When an infant awoke and began to vocalize, the observer stood beside the crib and took records until vocalization ceased. This was done in turn with each child in the nursery. Sometimes more than one infant would vocalize simultaneously. In this situation, a sample of breaths of one infant was completed before a sample of the other was taken. Thus, no conflict of observation arose, which might distort the results.

The unit of measurement was a behaviour rather than a time unit. The type and number of sounds were recorded for twenty or more discrete breaths for each subject and were taken only on the exhalation phase of breathing. The sounds were recorded in terms of the International Phonetic Alphabet as described by Fairbanks (2). The breath as a unit of measurement is advantageous because its length is easily within the attention span of the observer, thus permitting higher reliabilities between research workers. The International Phonetic Alphabet permits standardization of the qualitative aspects (the content) of the sounds.

No direct measure of observer reliability could be calculated since the data were collected by a single observer. This reliability has been reported elsewhere (5). In each of these studies the reliabilities reported have been of such a consistently satisfactory nature as to permit us to assume an equally satisfactory reliability for the purposes of the present study.

The reliability of the data was determined by the split-half method. Odd and even sounds as they came constituted the two halves of the data. The formula used has been described else-

where (6). The mean percent of agreement for each differential condition is 90. The range is 66 to 100 for crying sounds. The range for non-crying sounds is 71 to 100.

The distribution of percentages of agreement is presented in the following tabulation.

	CRYING	NON-CRYING
91-100	33	26
81- 90	9	8
71- 80	8	8
61- 70	2	0

Half of the reliabilities for the non-crying data, and over half of the reliabilities for the crying data, fall in the upper interval, 91-100. It is therefore quite evident that there exists a very satisfactory degree of internal consistency in the data.

The Results[1]

The data were analyzed both with regard to frequency, the number of sounds a given child made on all recorded breaths without discounting for any reduplication of sound content, and with regard to type, the number of sounds a given child made on all recorded breaths with any repetition of a given sound discarded. The frequency measure merely indicates the degree or amount of vocalization, whereas the type measure indicates the breadth and richness of vocalized sounds.

Type and frequency measures were calculated for both orphanage and family groups at each successive age level period according to the following conditions:

1. An over-all analysis, combining both crying and non-crying data and consonant and vowel data.
2. An analysis of non-crying data separately, combining both consonant and vowel sounds.

The non-crying data were then broken down into:

1. A comparison of mean vowel and consonant types for both experimental and control groups at the three different age levels.
2. A comparison of mean vowel and consonant frequencies for both groups at the three different age levels.

The results of these analyses are shown in Figures 1 and 2.

[1] *For the detailed statistical treatment of these data see the original thesis in the library of the State University of Iowa: Brodbeck, Arthur J. The phonetic status of orphanage infants: The first half year. Unpublished Master's thesis, State University of Iowa, 1946.*

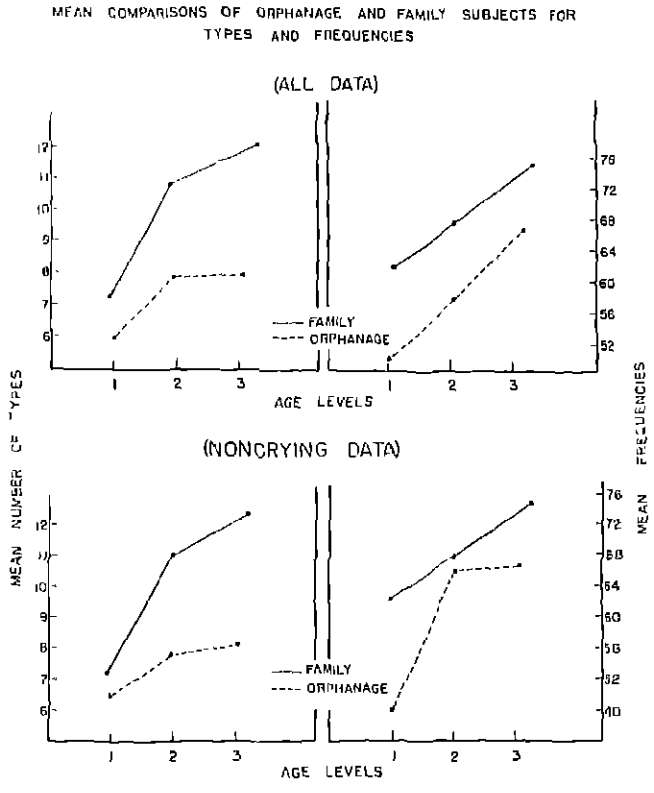

FIGURE 1

An examination of the graphs reveals some similarities. All of the graphs show that the means for orphanage infants fall below the means for family infants at all age levels and for both all type and all frequency measures. Regardless of the reliabilities of the differences, there is little doubt as to the consistency of this finding.

Moreover, the shape of the curves for the two groups is dissimilar. Wherever the speech sound growth curve for orphanage babies reaches a plateau between the second and third age levels, the curve for family infants shows some increment. The former curves flatten out in almost two-thirds of the comparisons, and especially for all analyses of type differences, both with consonant and vowel sounds combined and analyzed separately. There appears, then, to be a differential growth pattern for the two populations.

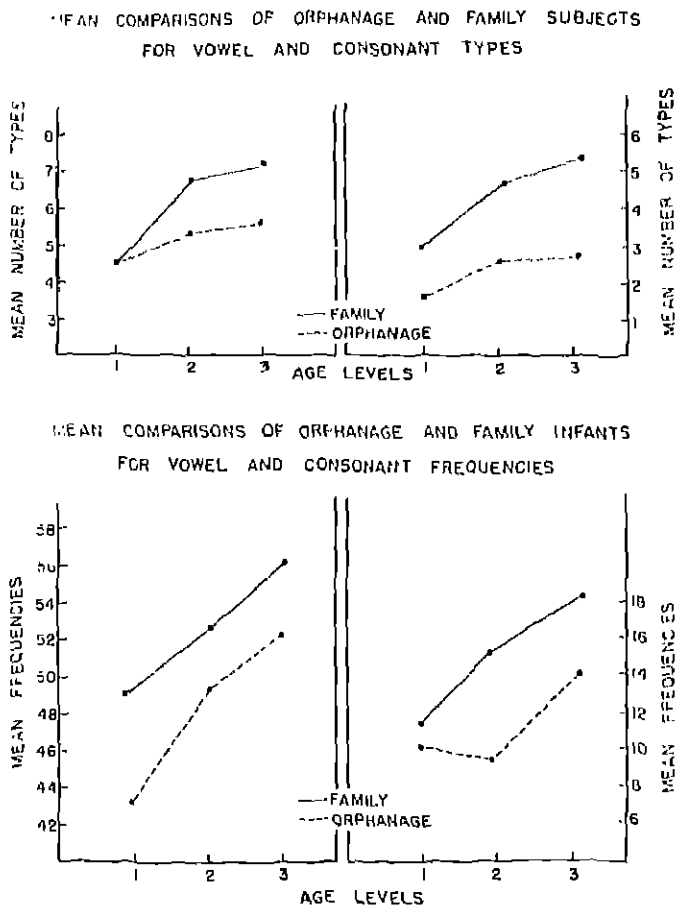

FIGURE 2

TABLE 1

FREQUENCY AND PERCENTAGE DISTRIBUTION OF CRITICAL RATIOS

C.R.	Level of Confidence	Frequency		Type	
		No.	Percent	No.	Percent
2.58+	(1%)	1	8	7	58
2.33+	(2%)	0	0	0	0
1.96+	(5%)	0	0	3	25
1.64+	(10%)	2	17	0	0
below 10%		9	75	2	17

Table 1 shows the frequency and percentage distribution of critical ratios for the mean differences between the two groups for both the type and frequency measures shown in Figures 1 and 2. If we take the 1 percent level of confidence as acceptable (which is equivalent to a critical ratio of 2.58), then more than half (58 percent) of the type differences prove to be significant, while only one (8 percent) of the frequency measures falls above this value.[2] Consonant type differences between the two groups were reliable at all three age levels, and type differences for the crying data, with consonant and vowel sounds combined, became progressively more reliable with increase of infant's age, with a critical ratio of 3.72 obtained at the third age level period.

Having made these analyses, it was still possible that the differences found between the two groups with regard to speech behaviour might be due to a selective socio-economic factor, operative in the placement of infants in the orphanage. We know, in general, that the lower socio-economic groups tend to be somewhat retarded in language development when compared

[2] *It is somewhat difficult to interpret the fact that, while both all type and all frequency mean differences favored the family group, only the type differences proved to be consistently reliable. However, it is to be remembered that the unit of measurement was a behaviour unit, so set up as to arbitrarily exclude extremes of vocalization frequency. That is, records were taken only on breaths during which the infant was making some sound and excluded breaths on which no sound was made. On the other hand, the average breath of an infant may not be long enough to permit reliable discrimination between two individuals or groups. Thus, it is conceivable that one infant may vocalize 400 times a day, while another might vocalize only 200 times a day and, yet, both individuals might vocalize to the maximum on a single breath. The breath unit might in this manner set an arbitrary high and low ceiling above which no reliable discrimination is possible.*

These speculations lead us to believe that a time unit of measurement, under approximately similar stimulating conditions, might increase the range of variability so as to lead to reliable differences between the two populations with respect to frequency of vocalization. A possible unit might be the time elapsing a half hour before feeding to the moment of the actual presentation of the breast or bottle.

Some confirmation for our hypothesis is the fact that, with the exception of consonant frequencies, the most reliable frequency differences were at the earliest age level where we would expect the range of variability to be smallest, and the least reliable were at the later age levels where we would expect the range of variability to be greatest.

with higher-status groups. The family infant data were, therefore, broken down into a professional and unskilled group and the same measures were calculated for each of these subsidiary groups as they had been for the family infant group as a whole previously. The mean results are shown in Table 2.

TABLE 2

COMPARISON OF ORPHANAGE DATA WITH FAMILY DATA OF DIFFERENT SOCIO-ECONOMIC LEVELS

(Non-crying Data)

Periods	1	2	3
	Types		
Professional	7.4	10.7	12.7
Unskilled	7.6	10.9	13.3
Orphanage	6.4	7.7	8.0
	Frequencies		
Professional	60.1	62.2	71.2
Unskilled	60.3	70.6	62.2
Orphanage	48.1	66.1	66.8

An inspection of these means makes it quite evident that there are no very large differences between the two socio-economic groups, and that these small differences tend to favor the lower socio-economic group, especially for those type measures which proved most reliable in the original orphanage and family group comparisons. Furthermore, for all measures of type, the orphanage means deviated from the means of both family groups several times more than did either of the two occupational groups deviate from each other. The deviation of the orphanage means also becomes appreciably greater with age, but the socio-economic deviations do not. The means of the frequency measures did not show any similar consistent trend. It would, therefore, seem to follow that the reliable differences which have been found between orphanage and family infants cannot be solely attributed, if at all, to a selection of orphanage babies from the lower socio-economic strata of the community. Yet the fact that at later ages speech sounds do actually reflect the differences between socio-economic groups, found by other

widely-used tests of language development, is more or less manifested in the results of an unpublished study made by one of the authors, which shows that the curves for the higher socio-economic groups begin to exceed that of the lower group at about one year of life.

Discussion

In her recent book, Infants Without Families, Anna Freud (3) puts forward the observation, based upon clinical work at the Hampstead Nursery, that children under one year of age separated from their parents use speech sounds "as extensively and not less than other children." This result, which of course was not based on any systematic unit of measurement comparable to our frequency and type measures, is explained by the children's drive to gain oral-erotic pleasure during the first year of life and is said to be all the more active, the more the child is left to itself. Dr. Freud does find differences between infants with and without families during the second year of life with regard to the use of patterned speech (words). Such differences disadvantageous for orphanage infants are explained as due to an absence of some form of imitation resulting from the lack of identification or relationship with a mother. In other words, the identification mechanism is not assumed to have differential effects on speech behaviour during the first year of life, and becomes crucial only during the second year when the child begins to use patterned speech.

There is no reason to doubt the precision of Dr. Freud's observations. On the basis of our own results and those of several other investigators, however, there does appear to be some reason to doubt the generality of her theoretical explanations. A recent study by William Goldfarb (4) showed that this deficiency with regard to speech sounds, as well as to other uses of language, continues right up to the third year of life among institutional children, and even after a period of foster home replacement. If the use of speech sounds per se was a function solely of a universal oral drive as Freud hypothesizes, why should these differences continue until the preschool ages, as Goldfarb demonstrated, when the child has already passed through the oral stage of development? Here, again, Dr. Freud underestimates the permanent and primary effects which the early mother-infant relationship exerts, and indeed predicts that the speech differences due to absence of the mother in the second year will be cancelled at the preschool ages, a prediction in flat contradiction to Goldfarb's findings.

Goldfarb, as well as others, has suggested that, through transient and impersonal attendance and in the absence of a

fixed, loving adult, the infant even before the first year cannot readily identify with any of the cultural surrogates around him, and is not motivated to do so, thus remaining retarded in all those functions which depend on social forms of imitation and communication. Presumably, the activity of babbling is at least in part one of these functions, as Lewis (7) and Miller and Dollard (8) have tried to demonstrate. If this hypothesis should be true, then on the basis of our data, the "identification" mechanism may be crucial even during the first six months of life. Dr. Goldfarb specifically states:

> "As early as six months and possibly even somewhat before, one observes the beginnings of sentiments, particularized attitudes, and attachments to a particular person or limited number of people within the primary family circle. Placement observation of babies separated from the parent person at this age indicates that the children experience psychological shock which sometimes may even be prolonged in nature. Nor is the shock ameliorated, for instance, by the simple satisfaction of hunger. A psychological relation between child and specific adult must be reconstituted before the baby's habitual expression of complacency is again observed. Close attachment to specific adults considerably before the end of the first year thus appears to be a fact." (p. 18)

It may very well be that the Hampstead Nurseries are not truly representative of the conditions that regularly exist in most orphanage institutions in the United States. And, as a matter of fact, some of our orphanage babies were well above the means for family infants. We believe that such individual cases (which were exceedingly rare) may be explained by the fact that a worker occasionally develops a fondness for a particular child and would, as a consequence, be more inclined to speak to it and encourage it to answer, as well as to give it more frequent all around stimulation. There is evidence that the social environment of the Hampstead Nursery was more uniformly of such a character. At least this seems a more reasonable hypothesis than Dr. Freud's toward explaining both the results obtained by Goldfarb and ourselves. It is in line, too, with the general clinical results reported by Margaret Ribble (9, 10) although she uses the same psychoanalytic principle of oral-eroticism to explain directly contradictory results to those found by Dr. Freud. Ribble seems to imply that, given a strong oral drive (measured in other than vocalization units) plus the absence of a fixed, affectionate adult, non-crying vocal-

ization (babbling) will be proportionately diminished. It may be, of course, that the two explanations (oral-eroticism vs. communication and imitation) are not incompatible and that only a multiple set of hypotheses can adequately explain the empirical findings regarding early speech behaviour. Until the oral-erotic principle is applied less ambiguously however, it is difficult to assign its relative weight at any stage of development.

Apparently what is needed now by way of rigorous investigation is some kind of clinical survey of the life histories of individual orphanage children who scored extremely low and extremely high when compared with the means of infants living in their own homes. By this method we may be able to isolate the more concrete cultural factors within the orphanage that have made for the manifest differences in speech behaviour. Secondly, there is the possibility of taking a more direct experimental approach through subjecting these children to types of treatment differing from that which they would ordinarily receive under orphanage conditions and measuring the resulting speech behaviour at the conclusion of the experimental treatment. This last procedure would be the more difficult of the two, in so far as it is rather trying to quantify all the factors that might go into such experimental treatments, but it would be more gratifying from the point of view of assessing the relative quantitative importance of a set of independent and manipulatable variables. At any rate, until some work like this is done, all our theoretical explanations remain somewhat academic.

SUMMARY

A group of orphanage infants ranging from one day to six months of age was compared with family infants of the same age range, with respect to various measures of speech behaviour. It was found that:

1. A graphical comparison showed that the orphanage means fell below those of the family means at all age levels and for both type and frequency measures.
2. More than half (58 percent) of the type differences proved to be reliable, but only one (8 percent) of the frequency measures was satisfactory.
3. Consonant type differences were reliable at all age levels, and type differences for the crying data, with vowel and consonant sounds combined, became progressively reliable with increase of age.
4. When the family infant data were broken down into professional and unskilled family groups and again compared with orphanage infants, the orphanage means were found to deviate

from the means of both family groups several times more than did either of the two socio-economic groups deviate from each other, especially for those measures which showed reliable differences between the orphanage and family groups as a whole previously. This finding more or less ruled out the possibility of attributing the previous results solely to a selection of the orphanage infants from lower social status groups.

5. Some exception was taken to the use of the identification mechanism and of the oral-erotic principle by Anna Freud in explaining age differences in infant speech behaviour.

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INDIVIDUAL GROWTH IN HIP WIDTH: A STUDY COVERING THE AGE PERIOD FROM 5 TO 9 YEARS BASED UPON SERIATIM DATA FOR 55 NONPATHOLOGIC WHITE CHILDREN

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There is need for "more studies relating to the growth changes of the individual" (1). This need is recognized not alone by research anatomists and physiologists (2, 3, 4, 5, 6, 7), but by every pediatrician and school physician interested in health appraisals which take into account the individual's "progress of growth" (8, 9).

The purpose of the present paper is to report a study pertaining to growth changes of the individual in hip width. The individual protocols analyzed extend over the four-year postnatal period from 5 to 9 years of age.

Five problems are investigated. The first is the form of individual growth curves. Here the question raised is whether all well children manifest a similar pattern of hip width growth or whether commonly found growth trends are of two or more different forms. The second problem relates to the hip width rank of the individual at successive ages. It is concerned with the validity of the assumption that a child who has narrow hips at age 5 years can be expected to have narrow hips at age 9 years, and vice versa. The third problem is that of deriving and analyzing year-by-year increments in the hip width. A central objective here is to afford normative materials which can be used as "frames of reference" both in experimental research and clinical practice. The fourth problem treats percentile gains in hip width over two consecutive bi-annual age periods and over the entire four-year period. Findings are presented indicating age, sex, and individual differences in rate of growth. The final problem considered deals with the relationship between hip width status and hip width increase. On this topic, the leading question posed is: do individuals who have wide hips at age 5 make large gains in hip width during the succeeding two or four years, and vice versa?

Subjects

The subjects were 55 white children - 35 males and 20 females - residing in or near Iowa City and attending the University of Iowa experimental elementary school. All were physi-

cally normal (one, Subject 9038, became moderately obese around 7 years of age) and all except one were born in North America (Subject 5327 was born in Germany).

From the standpoint of socio-economic status, the subjects represented an upward selection. Information on occupation of the father showed 76 percent to be professional men (mainly members of the University faculty), 20 percent business proprietors or managers, and the remaining 4 percent skilled or semiskilled employees. Another indicator of socio-economic selection upward lies in the choice of the University school - involving unsolicited application for enrollment, moderate tuition, and transportation expense.

Approximately 90 percent of the subjects were of northwest European ancestry. The principal exceptions were Subjects 1124, 1149 and 1157,[1] whose parents were born in Poland. No less than two-thirds of the subjects could be characterized as white children of "Old American stock," both of their parents and all four of their grandparents having been born in North America.

Each subject was examined at semiannual intervals during the period from 5 to 9 years of age.

Data

As may be seen from Table 1, the data consist of nine records for hip width on each of 55 children. Their accumulation took place over the years 1937-1946, some of the children being first measured in the fall of 1937 and others at later dates through the spring of 1942.

The procedure followed in obtaining the records was exceptionally rigorous. At each semiannual age hip width was taken independently by two anthropometrists. If these two measurements differed by more than 1 mm., both anthropometrists secured additional measurements. As a consequence, each record is highly dependable - representing either the mean of two measurements which differed by not more than 1 mm. or the median of no less than four measurements.

Hip width was determined in the region of the crests of the ilia, i.e., as bi-iliocristal diameter.[2] Using large aluminum sliding calipers (the Hrdlička compass), the distance was measured between the lateralmost point of the crest of the right

[1] *Subjects 1124 and 1157 were siblings, Subject 1149 a cousin.*

[2] *This dimension has been referred to by different investigators as bi-iliac diameter, intercristal distance, and pelvic breadth.*

TABLE 1
SERIATIM RECORDS FOR BI-ILIOCRISTAL DIAMETER (centimeters) ON 55 WHITE CHILDREN

Subject	Age in Years: 5	5½	6	6½	7	7½	8	8½	9
				Males					
130	18.30	18.70	19.10	19.55	19.90	20.25	20.55	20.85	21.15
216	19.60	20.10	20.50	20.85	21.15	21.45	21.75	22.05	22.35
724	17.30	17.80	17.95	18.30	18.65	18.95	19.20	19.50	19.75
892	18.60	19.00	15.45	19.95	20.40	20.80	21.15	21.55	21.95
1124	17.35	17.80	18.20	18.55	18.90	19.20	19.45	19.70	19.90
1149	18.55	18.85	19.15	19.50	19.90	20.25	20.60	21.00	21.40
2107	19.00	19.45	19.90	20.30	20.70	21.10	21.55	21.95	22.40
2755	18.40	18.85	19.25	19.65	20.05	20.45	20.80	21.05	21.30
2817	18.00	18.45	18.85	19.25	19.60	19.90	20.25	20.55	20.80
3057	18.10	18.45	18.80	19.10	19.40	19.70	20.00	20.35	20.80
3159	18.30	18.80	19.25	19.65	20.05	20.45	20.90	21.40	21.90
3572	17.80	18.25	18.65	19.05	19.55	20.00	20.40	20.85	21.20
3630	17.90	18.30	18.75	19.10	19.40	19.70	20.00	20.30	20.60
4277	17.80	18.15	18.50	18.90	19.30	19.75	20.20	20.65	20.95
4397	16.60	16.95	17.25	17.60	18.00	18.40	18.75	19.05	19.30
4438	17.25	17.65	18.05	18.40	18.75	19.10	19.45	19.80	20.15
4619	20.15	20.60	21.10	21.50	21.90	22.40	22.95	23.35	23.75
4716	17.90	18.25	18.65	19.10	19.50	19.85	20.15	20.40	20.65
4817	18.85	17.20	17.65	18.10	18.50	18.90	19.25	19.60	19.95
4938	19.25	19.75	20.25	20.70	21.10	21.75	22.40	22.90	23.30
5327	18.70	19.15	19.60	20.00	20.35	20.70	21.00	21.40	21.70
5374	16.55	16.85	17.15	17.50	17.85	18.20	18.55	18.90	19.25
5467	18.65	19.10	19.55	19.90	20.30	20.80	21.40	21.95	22.50
6003	20.00	20.45	20.95	21.45	21.85	22.25	22.65	23.05	23.45
6134	19.25	19.60	20.10	20.55	21.00	21.35	21.65	22.00	22.35
6206	18.95	19.45	19.95	20.35	20.80	21.25	21.70	22.15	22.50
6693	16.90	17.20	17.55	17.85	18.10	18.40	18.70	19.00	19.35
6718	16.95	17.30	17.60	17.95	18.30	18.65	19.00	19.30	19.60
6799	18.15	18.55	19.00	19.40	19.80	20.20	20.55	20.85	21.15
7056	17.40	18.00	18.60	19.00	19.35	19.60	19.80	20.05	20.35
7291	18.95	19.30	19.60	19.95	20.30	20.60	20.90	21.20	21.50
7393	17.85	18.40	18.85	19.25	19.60	19.90	20.25	20.55	21.00
9038	18.30	18.80	19.35	19.90	20.50	21.15	21.55	21.85	22.70
9582	18.75	19.35	19.85	20.30	20.70	21.05	21.40	21.70	21.95
9588	17.65	18.00	18.40	18.80	19.20	19.50	19.85	20.15	20.50
				Females					
211	18.00	18.50	19.00	19.35	19.65	19.95	20.25	20.65	21.05
385	18.35	18.70	19.10	19.50	19.90	20.30	20.65	21.00	21.40
424	16.90	17.20	17.45	17.70	18.00	18.40	18.80	19.20	19.70
753	18.80	18.85	19.15	19.45	19.80	20.20	20.70	21.25	21.70
1013	17.30	17.60	17.95	18.25	18.55	18.85	19.20	19.60	20.10
1157	18.80	19.20	19.55	19.95	20.30	20.70	21.10	21.55	22.05
1673	17.40	17.75	18.15	18.50	18.90	19.30	19.75	20.25	20.75
2049	18.10	18.65	19.15	19.70	20.20	20.65	21.15	21.70	22.25
2178	17.60	18.10	18.60	19.10	19.55	20.00	20.45	20.90	21.30
2310	18.10	18.50	18.95	19.30	19.85	20.20	20.80	21.30	21.75
2333	18.60	19.00	19.45	19.85	20.25	20.70	21.20	21.70	22.10
2678	18.10	18.55	18.95	19.35	19.75	20.10	20.50	20.95	21.40
4224	18.70	19.20	19.70	20.15	20.60	21.00	21.45	21.90	22.35
4746	17.20	17.55	17.95	18.45	18.95	19.45	19.95	20.50	21.10
4937	19.40	19.90	20.50	21.00	21.50	21.90	22.25	22.60	23.00
5413	18.15	18.55	19.00	19.50	20.00	20.55	21.10	21.70	22.25
7535	18.15	18.65	19.05	19.40	18.75	20.00	20.30	20.60	20.90
7735	17.75	18.15	18.50	18.80	19.15	19.45	19.80	20.15	20.50
8885	17.10	17.30	17.60	17.95	18.40	18.80	19.15	19.45	19.75
9356	16.80	17.50	18.10	18.55	19.00	19.40	19.80	20.40	21.00

ilium and the corresponding landmark for the left ilium. Always the subject was nude and oriented in the erect position with his weight equally distributed through both lower extremities. The anthropometrist stood in front of the subject and brought the face of each branch of the calipers squarely in contact with one of the landmarks. The maximum pressure was applied that could be exerted without pain to the subject.[3] In the event the subject turned his hips as the pressure was being applied, the measurement was retaken.

Findings

As indicated in the introduction, findings were sought on five facets of the problem of individual growth in hip width. These findings will be presented under the captions: Form of individual curves, Rank of individual at successive ages, Annual centimeter increase in hip width, Percentage gain in hip width, and Relationships between size and increment.

Form of Individual Curves

Leading question: Is there a single pattern of growth in hip width over the years from 5 to 9, or do different individuals manifest a variety of growth patterns?

The trend line of hip width on age was drawn for each of the 55 subjects. Age constituted the x-axis of these 55 graphs and hip width the y-axis. Each point plotted represented bi-iliocristal diameter (ordinate) at a given semiannual age (abscissa). The nine successive points for every individual were connected to yield individual curves - absolute magnitude trends - covering the age period from 5 years to 9 years.

Inspection of the curves gave the gross finding of all gradations in form or pattern from moderately convex, through linear, to moderately concave, together with a few somewhat more complex trends (e.g., convex-concave, concave-convex). Further intercomparison led to subdivision of the curves into four groups - linear, convex, concave, miscellaneous - and, subsequently, to the construction of Figure 1, which will be seen to utilize the data on 35 of the 55 individuals:

1. Section A presents 11 curves of a practically linear form. The representations of males (64 percent) and females (36 percent) are the same as for the total sample. Subjects 4224, 2049, 383 and 7735 are females.

[3] *Objective: firm compression of the soft tissues overlying the skeletal landmarks.*

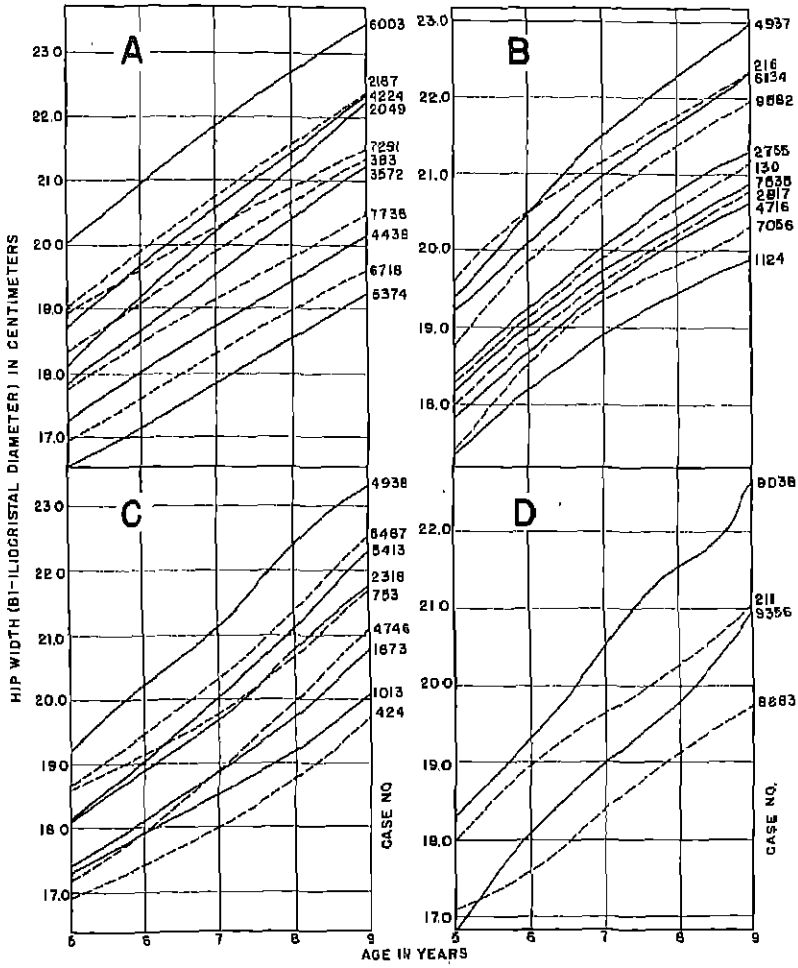

Figure 1. Four groups of individual curves for hip width extending over the age period from 5 years to 9 years. See the text of the paper for a description of each group and Table 1 for a listing of the values to which each curve was drawn.

2. Section B displays 11 curves of a generally convex form. In each instance the amount of rise from 5 to 7 years exceeds the amount of rise from 7 to 9 years by more than 0.3 cm. Four of the curves (4937, 9582, 7056 and 1124) ascend between 0.5 and 1.0 cm. more over the period 5 to 7 years than over the period 7 to 9 years. Convex trends occur with greater frequency among the males than the females: while females constitute 36 percent of the total sample, they constitute only 18 percent of Section B (4937 and 7535).

3. Section C portrays nine curves of a generally concave form. In each instance the amount of rise from 5 to 7 years is between 0.3 and 0.7 cm. less than the amount of rise from 7 to 9 years. Four of the curves (5467, 753, 2318 and 424) register a greater ascent over the latter biennium than over the former by upwards of 0.5 cm. More females than males are found to yield concave growth trends: the only males in Section C are 4938 and 5467.

4. Section D exhibits four curves placed in the miscellaneous group. Curves 211 and 9356 follow a convex-concave trend: both are females. The trend for 8883 (female) is concave-convex. Less marked concavity combined with greater convexity is registered in the pattern for the female 4937, Section B. The curve 9038 represents a male who became moderately obese in late childhood: part of its convex-concave form between 7 and 9 years of age might represent fluctuations in the compressibility of the subcutaneous adipose tissue overlying the landmarks. Attention is called to 4938 in Section C; possibly this curve should be grouped with the miscellaneous rather than with the concave.

It should be obvious that the four sections of Figure 1 do not illustrate discrete classes of curves. Sections B, A and C circumscribe three sectors of the continuum from a simple convex form through to a simple concave form. Section D presents the more extreme varieties of multiple-phase curves (i.e., trends composed of more than one growth cycle). The four sections together constitute an attempt to clarify and systematize the gradations found: they should not be interpreted as an attempt to minimize the intergrades.

Rank of Individual at Successive Ages

Leading question: Does the child who has wide hips at 5 years of age have wide hips at 7 and 9 years of age? Conversely, to what extent does the five-year-old child whose hips are narrow show a tendency at later childhood ages to maintain (or to change) his positional standing in the group?

Figure 2 displays curves for hip width (bi-iliocristal diameter) from 12 individuals. These curves were selected and arranged to illustrate constancy of position from age to age (Section A) and various combinations of marked divergence resulting from age to age shifts in rank (Sections B to F). The six sections of Figure 2 are conveniently discussed in alphabetic order:

1. Section A. Subjects 2187 and 6799 typify individuals who held approximately the same position in the hip width distributions for successive ages. At 5, 7, and 9 years, the percentile ranks of Subject 2187 fell between 84 and 86, those of Subject 6799 between 50 and 55. For roughly one-third of the subjects of each sex, the fluctuations in percentile rank over the years from 5 to 9 did not exceed five points. Additional instances are Subject 4619, with percentile ranks at 5, 7 and 9 years of 98; Subjects 6003 and 5374, with constant ranks at like ages of 96 and 2 respectively; Subject 4397, with ranks of 4 and 5; and Subjects 4937 and 4438, with ranks of 92 to 94 and 20 to 22 respectively.

2. Section B. Compared with Subject 2049, the hips of Subject 7291 were wider by 0.85 cm. at 5 years, practically equivalent at 7 years, and narrower by 0.75 cm. at 9 years. In terms of percentile rank, Subject 7291 underwent a downward change of 24 points (from 84 at 5 years to 60 at 9 years) and Subject 2049 an upward change of 27 points (from 50 at 5 years to 77 at 9 years). A similar relationship was found for Subjects 3057 and 2178, the former declining in percentile rank from 50 to 34 and the latter shifting upward from 28 to 53.

3. Section C. The hip widths of Subjects 216 and 5413 converged from a difference of 1.45 cm. at 5 years to almost no difference at 9 years. The percentile ranks at 5 and 9 were 94 and 81 for Subject 216, 54 and 77 for Subject 5413: It follows that the percentile rank differences decreased from 40 at 5 years to 4 at 9 years. Similar convergence over the same age period occurred for Subjects 2755 and 4746, the former decreasing in percentile rank from 66 to 53 and the latter increasing from 18 to 46.

4. Section D. Subjects 9356 and 6693 showed gradual divergence from hip widths that were alike shortly after 5 years of age to hip widths differing by 1.65 cm. at 9 years of age. These individuals had identical percentile ranks at age 5 years 2 months (ranks approximating 10) and gave a difference in percentile rank of 35 points at age 9 years (Subject 9356's rank was 41, that of Subject 6693 was 6).

5. Section E. The hip widths of Subjects 753 and 7535 converged during the sixth and seventh years and diverged during the eighth and ninth years. At age 5 the percentile ranks dif-

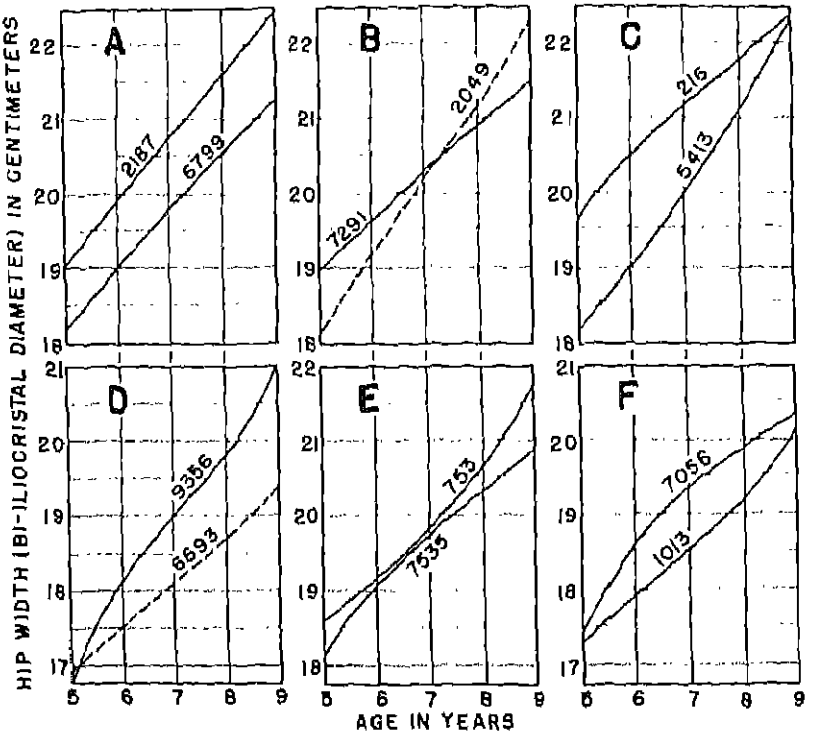

Figure 2. Twelve individual curves for hip width extending over the age period from 5 to 9 years. See the text of the paper for a discussion of each section of the graph and Table 1 for a listing of the values to which each curve was drawn.

fered by 22 points, at age 7 the differences were negligible, and at age 9 they differed by 27 points.

6. Section F. Subjects 7056 and 1013 diverged in hip width between 5 and 7 years and converged between 7 and 9 years. The differences in percentile rank were 4 at 5 years, 18 at 7 years and 4 at 9 years.

The purpose of Figure 2 and its complementary discussion has been to present selected instances of (a) constancy of rank and (b) marked change in rank. It is now pertinent to extend consideration of the problem of positional standing to the entire series of subjects. The tabulation which follows gives the frequency with which individuals were found to deviate in percentile rank by specified amounts.

Change in Percentile Rank	5 to 7 years		5 to 9 years	
	Number	Percent	Number	Percent
0 - 9	48	87	32	58
10 - 19	4	7	16	29
20 - 29	3	6	5	9
30 - 39			2	4

Individuals registering shifts in rank of less than 10 percentile points appear appropriately regarded as remaining "roughly constant." Employing this designation, roughly constant hip width ranks characterized more than four-fifths of the subjects over the two-year period from 5 to 7 and more than one-half of the subjects over the four-year period from 5 to 9. For the interval between 5 and 7 years, only 6 percent of the subjects underwent "marked change," i.e., registered shifts in percentile rank of 20 points or more. For the interval 5 to 9 years there were 13 percent whose positions in the hip width distributions showed "marked change." The maximum displacement for any individual was 35 percentile points, the equivalent of approximately one-third of the percentile distribution.

Two additional methods of analysis were considered helpful in elucidating the problem under study. One of these was the method of correlation. The other was the method of taking all the individuals making up some portion of the distribution for a given variable at a certain age and tracing their disposition in the distribution for the variable at some other age. Taking the individuals that constituted the middle 50 percent of the hip width distribution at 5 years, their dispersion in the distribution at 9 years was as follows: 6 percent were among the highest one-fourth, 38 percent among the central one-half, and 6 percent among the lowest one-fourth. Similarly for the individuals that constituted the middle 50 percent of the ordered series of hip widths at 9 years - in the distribution at 5 years, 6 percent

were among the highest fourth, 38 percent among the central half, and 6 percent among the lowest fourth. The product-moment coefficient of correlation (r) expressing the relationship between hip width at 5 years and hip width at 9 years was .90 ± .02.[4]

Annual Centimeter Increase in Hip Width

Leading questions: How much per year does the typical elementary school child increase in hip width? During a given annual age period (e.g., between 6 and 7 years of age) to what extent do physically normal individuals differ in their hip width increments?

For each of the 55 subjects, the difference was computed between hip width at age 5 and hip width at age 6. A like procedure was followed in obtaining centimeter gains in bi-iliocristal diameter for the yearly age periods 6 to 7, 7 to 8, and 8 to 9. The four series of increment values were then subgrouped according to sex, and the mean increase obtained for each sex during each successive year.

Sex	Number of Subjects	Age Interval (years): 5 to 6	6 to 7	7 to 8	8 to 9
Males	35	0.84	0.78	0.74	0.71
Females	20	0.84	0.80	0.83	0.90

From this tabulation of the results, it will be seen:

1. The means for males and females representing the year 5 to 6 are identical.
2. There is a slight yet consistent decline in the male means from year to year.
3. For the age intervals 7 to 8 and 8 to 9, the female means are somewhat larger than the male means. The sex difference in centimeter gain during the latter year is statistically significant ($t = 4.2$).[5]

[4] *The coefficients for each sex separately were males (N = 35) .94 ± .01 and females (N = 20) .84 ± .05.*

[5] *This finding, considered in conjunction with the earlier timing in females of the so-called adolescent acceleration in hip width, suggests the possibility that the slightly greater mean gains for females than males during the eighth and ninth years reflect the gradual approach of at least some of the females to marked acceleration. The subjects are still being regularly examined and it is planned that a later study will follow their growth through the high school years.*

4. In general, the average yearly increase in hip width approximates 0.8 cm. for males 5 to 7 years of age, 0.7 cm. for males 7 to 9 years of age, 0.8 cm. for females 5 to 8 years of age, and 0.9 cm. for females 8 to 9 years of age.

Having epitomized the annual centimeter increments with reference to central tendency, we next subjected them to study from the standpoint of variability. In other words, findings were sought regarding individual differences in the amount of gain in hip width per year. Between the ages of 5 and 7 years (lacking any evidence of a sex difference in amount of gain) the data from both sexes were combined. For the succeeding two-year period (during which there was evidence of a slight tendency for females to gain more than males) the data from each sex were analyzed separately. The findings are presented in Table 2.

TABLE 2

ANNUAL INCREASE IN BI-ILIOCRISTAL DIAMETER (centimeters): Each row of the table designates an age interval, specifies the number of subjects studied, and affords four values describing the increment distribution. The subjects were white children of above average socio-economic status.

Age Interval (years)	N	Percentiles: Minimum	25th	75th	Maximum
		Both Sexes			
5 - 6	55	0.5	0.7	0.9	1.3
6 - 7	55	0.5	0.7	0.9	1.2
		Males			
7 - 8	35	0.4	0.6	0.8	1.3
8 - 9	35	0.4	0.6	0.8	1.2
		Females			
7 - 8	20	0.5	0.7	0.9	1.2
8 - 9	20	0.6	0.8	1.0	1.2

Generalizations which may be drawn include the following:

1. Over the age period from 5 to 7 years for both sexes, and from 7 to 8 for females, physically normal individuals occasionally gain as little as one-fifth inch per year (0.5 cm.) and as much as one-half inch per year (1.2 to 1.3 cm.). Fifty percent of individuals gain between 0.7 and 0.9 cm., while one child in four gains less than 0.7 cm. and one child in four more than 0.9 cm.

2. During the eighth and ninth years males tend to gain slightly less than during the sixth and seventh years. Twenty-five percent gain between 0.4 and 0.6 cm. annually, 50 percent

between 0.6 and 0.8 cm. annually, and the remaining 25 percent between 0.8 and 1.3 cm. annually.

3. In the case of females during the ninth year, one-fourth gain from 0.6 to 0.8 cm., one-half from 0.8 to 1.0 cm., and one-fourth from 1.0 to 1.2 cm.

4. During every year from the sixth through the ninth, individual differences among nonpathologic children are such that the hip width increases for some equal no more than one-half the increases of others. Conversely, the increments of a few are as much as twice those for a few others.

Percentage Gain in Hip Width

Leading questions: Does hip width at 9 years of age exceed hip width at 5 years by 5 to 10 percent, by 15 to 25 percent, or by 30 to 50 percent? Is the percentage gain in hip width greater between 5 and 7 years than between 7 and 9 years, or vice versa?

In obtaining an answer to the first question, values were derived expressing the gain (centimeter gain) of the individual between the ages of 5 and 9 years in terms of his size (actual hip width) at 5 years. The procedure was as follows: For each subject (a) the difference was calculated between hip width at 5 years and hip width at 9 years, (b) this difference was divided by hip width at 5 years, and (c) the resulting quotient was multiplied by 100 to put it in percentage form. The values obtained were grouped according to sex, ordered, and statistically reduced.

Age Interval (years)	Sex	N	Minimum	25th Percentile	Mean	75th Percentile	Maximum
5 - 9	Males	35	13	15	17	18	24
5 - 9	Females	20	15	16	19	20	25

The difference between the sexes was found to be significant at the 1 percent level of confidence ($t = 2.8$). In terms of hip width status at 5 years, the increases for males over the succeeding four-year period varied from 13 percent to 24 percent, with one-half falling between 15 percent and 18 percent, and the mean increase approximating 17 percent. For females, the mean percentage increment was around 19, the limits of the interquartile distance were 16 percent and 20 percent, and the extreme values 15 percent and 25 percent.

Turning now to the second question, two series of figures

were derived: one expressing the hip width gain of each individual between 5 and 7 years in terms of his hip width magnitude at 5 years, and the other expressing gain between 7 and 9 years in terms of size at 7 years. The procedure paralleled that described in computing percentage increments over the period 5 to 9 years. Prior to analysis the data for each biennium were subgrouped by sex. The results are shown in Table 3.

TABLE 3

PERCENTAGE GAIN IN HIP WIDTH OVER TWO ADJACENT BI-ANNUAL PERIODS

Age Interval (years)	N	Minimum	25th Percentile	Mean	75th Percentile	Maximum
			Males			
5 - 7	35	7	8	9	10	12
7 - 9	35	5	6	7	8	11
			Females			
5 - 7	20	6	8	9	10	13
7 - 9	20	6	7	9	10	11

Selected findings are:

1. For males the percentage increase in hip width tends to be higher over the period 5 to 7 years than over the period 7 to 9 years. The difference approximates 2 percent, and indicates a gradual decline in the growth rate with age. In the case of females the percentage increase is almost as great between 7 and 9 years as between 5 and 7 years.

2. Over the period from 5 to 7 years, the percentage-gain distributions of males and females are not appreciably different. For the succeeding biennium there is a statistically significant sex difference ($t = 3.7$), females tending to register systematically larger gains than males.

3. During the two years from 5 to 7, one-half of the subjects studied increased in hip width between 8 and 10 percent. The increases of the other half fell equally between 6 and 8 percent and between 10 and 13 percent. During the years 7 to 9, 25 percent of the males increased 5 to 6 percent and 25 percent of the females 6 to 7 percent; 50 percent of the males increased 6 to 8 percent and 50 percent of the females 7 to 10 percent; the remaining 25 percent each of males and females increased 8 to 11 percent and 10 to 11 percent respectively.[6]

[6]These materials suggested inquiry into the relationship between an individual's percentage gain over the biennium 5 to 7 and his percentage gain over the biennium 7 to 9. Employing the method of correlation, it was found: for both sexes, $r = .29 \pm .08$; for males, $r = .29 \pm .10$; and for females, $r = .29 \pm .14$.

Relationships between Size and Increment

Leading questions: Do individuals who have broad hips at age 5 make large gains in hip width over the years 5 to 7, or vice versa? What is the degree of association between hip width status at age 5 and increase in hip width between 5 and 9?

The hip width distribution for age 5 was separated into three parts - the upper one-fourth, the middle one-half, and the lower one-fourth. Similar three-segment subdivisions were made of the 5 to 7 and 5 to 9 distributions for centimeter gain in hip width.

Tabulation was then carried out to determine the frequency with which children in the highest quarter of the hip width distribution at 5 years were in (a) the highest quarter, (b) the central half, and (c) the lowest quarter of the distribution for gain in hip width from 5 to 7 years. Also determined was the mean gain between 5 and 7 for all subjects in the highest quarter of the distribution for age 5. In like manner analysis was extended successively to those in the middle half and in the lowest quarter of the hip width distribution at 5. Further, corresponding series of frequencies and means were obtained using, consecutively, the 5 to 9 year gains of those having (a) narrow, (b) medium and (c) wide hips at 5. The results are presented in Table 4.

TABLE 4

ASSOCIATION BETWEEN HIP WIDTH STATUS AT AGE 5 YEARS AND GAIN IN HIP WIDTH FROM 5 TO 7 YEARS AND FROM 5 TO 9 YEARS

Gain in Hip Width	Segments of Hip Width Distribution at Age 5		
	Lowest Quarter	Central Half	Highest Quarter
5 - 7 distribution:	%	%	%
Highest Quarter	13	19	43
Central Half	33	65	50
Lowest Quarter	54	16	7
	100	100	100
Mean Gain (cm.)	1.5	1.6	1.7
5 - 9 distribution:			
Highest Quarter	13	23	43
Central Half	40	58	43
Lowest Quarter	47	19	14
	100	100	100
Mean Gain (cm.)	2.9	3.2	3.4

It will be seen:

1. Individuals having narrow hips at 5 years (i.e., individuals in the lowest one-fourth of the age 5 distribution) made large, medium, and small gains between 5 and 7 years. A like finding accrues in the case of gains between 5 and 9 years for individuals with narrow hips at 5. Conversely, large, medium, and small gains from 5 to 7 and from 5 to 9 are found to occur among individuals having wide hips at 5.

2. There is a slight tendency for 5-year-old children with narrow hips to gain less over the succeeding two to four years than those with wide hips. Specifically, the mean gains between 5 and 7 for children in the lowest fourth, central half, and highest fourth of the 5-year hip width distribution are 1.5 cm., 1.6 cm., and 1.7 cm. respectively. Parallel mean gains over the period 5 to 9 years are 2.9 cm., 3.2 cm., and 3.4 cm. respectively.

3. Of the subjects constituting the lowest one-fourth of the hip width distribution at 5 years, 54 percent made small gains between 5 and 7, 33 percent medium gains, and 13 percent large gains. The percentages registering small, medium, and large gains between 5 and 9 years are 47, 40 and 13. Of the subjects constituting the highest one-fourth of the hip width distribution at 5, 43 percent made large gains between 5 and 7, 50 percent medium gains, and 7 percent small gains. The percentages showing large, medium, and small gains between 5 and 9 years are 43, 43, and 14.

The foregoing analyses lead to the generalization that there is not a high degree of relationship between the magnitude of a child's hip width at age 5 and the amount he gains in hip width during the succeeding two to four years. A succinct means of quantitatively expressing the relationship which does exist is available in the correlation coefficient. The product-moment method of correlation yields coefficients (r's) of .36 $\pm$ .08 for hip width at 5 with gain between 5 and 7 and of .31 $\pm$ .08 for hip width at 5 with gain between 5 and 9.[7] While these coefficients denote some degree of positive association between size and gain they are clearly too low to serve as useful media for predicting expected gain in an individual from a record of his size.

[7] *On males and females separately, the coefficients for size at 5 with gain from 5 to 7 were .48 $\pm$ .09 (males, N = 35) and .23 $\pm$ .14 (females, N = 20). For size at 5 with gain from 5 to 9 the corresponding coefficients were .50 $\pm$ .09 and .10 $\pm$ .15.*

SUMMARY

The subjects were 55 physically normal white children drawn predominantly from the professional and managerial classes. Each subject was examined at semiannual intervals between the ages of 5 and 9 years. At every examination a highly dependable record for hip width (bi-iliocristal diameter) was obtained. The total data (55 individuals measured at each of 9 equally spaced ages) consisted of 495 hip width records.

Findings are reported pertaining to five problems: the form or pattern of individual hip width curves; change with age in the hip width rank of the individual; normal variation in hip width increase per year; the rate of hip width growth for males and females; and, the degree of association between size of hips and amount of gain in hip width.

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SKELETAL MATURING AS RELATED TO STRENGTH[1]

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The aspects of muscular strength which can be measured by dynamometers (static dynamometric strength) are of special interest to the student of child development. These functions are significant not merely as an outcome of their relation to other physical abilities, and of their role in many kinds of motor performance, but also because strength is often an important index to traits which, among boys in adolescence, occupy a high position in the hierarchy of social values (6).

Strength measurements are also characterized by extremely wide individual differences, and by an intense and prolonged spurt of growth during the puberal period. Table 1 and Figure 1 show growth curves from age 11 to 17.5 for Gripping Strength (Right and Left), Pulling Strength and Thrusting Strength.[2] The

TABLE 1

DYNAMOMETRIC STRENGTH MEASUREMENTS, BY AGE (Boys)

		Right Hand		Left Hand		Pull		Thrust	
Age*	N**	Mean (Kg.)	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
11.0	65	25.14	4.09	23.46	3.93	18.41	3.71	21.86	4.78
11.5	87	26.28	3.89	24.91	3.63	19.16	4.31	22.14	5.00
12.0	93	27.62	3.71	26.29	3.69	20.72	4.42	24.30	5.26
12.5	90	29.37	4.42	27.69	4.06	22.24	5.42	26.14	5.56
13.0	92	30.96	4.60	28.77	4.58	23.26	6.26	27.46	6.22
13.5	92	33.39	5.68	31.50	5.15	25.69	6.63	30.49	7.08
14.0	89	36.33	6.96	33.82	6.11	28.79	7.33	32.51	9.34
14.5	84	39.55	7.24	37.06	6.06	31.28	7.53	35.75	8.65
15.0	84	43.40	7.15	40.48	7.03	34.71	7.98	39.61	10.61
15.5	77	46.62	7.35	43.61	7.25	38.82	8.63	42.97	10.58
16.0	76	49.10	7.09	45.65	6.77	43.10	9.53	47.70	10.87
16.5	77	51.74	6.82	48.73	6.48	45.02	8.74	52.45	10.00
17.0	77	54.50	7.06	50.08	7.03	49.25	9.17	56.04	10.40
17.5	62	56.26	7.25	52.28	6.94	50.42	9.30	58.20	10.49

*The class interval is 10.75 to 11.24 etc.

**N is for the Right Grip measurements. Approximately the same sample is involved in the other measurements, except that at some ages two or three individuals who could be tested for one hand could not (due to minor injuries) be tested for the other hand, or on bi-manual tests.

[1]The materials included in this report are presented in greater detail in a volume now in press (7).

[2]The instruments and procedures in measurement are described in (7). In the test of Pulling Strength the dynamometer is held at chest level and the two hands pull outward or away from the midline of the body. In the test of Thrusting Strength the two hands push together in a compressing movement.

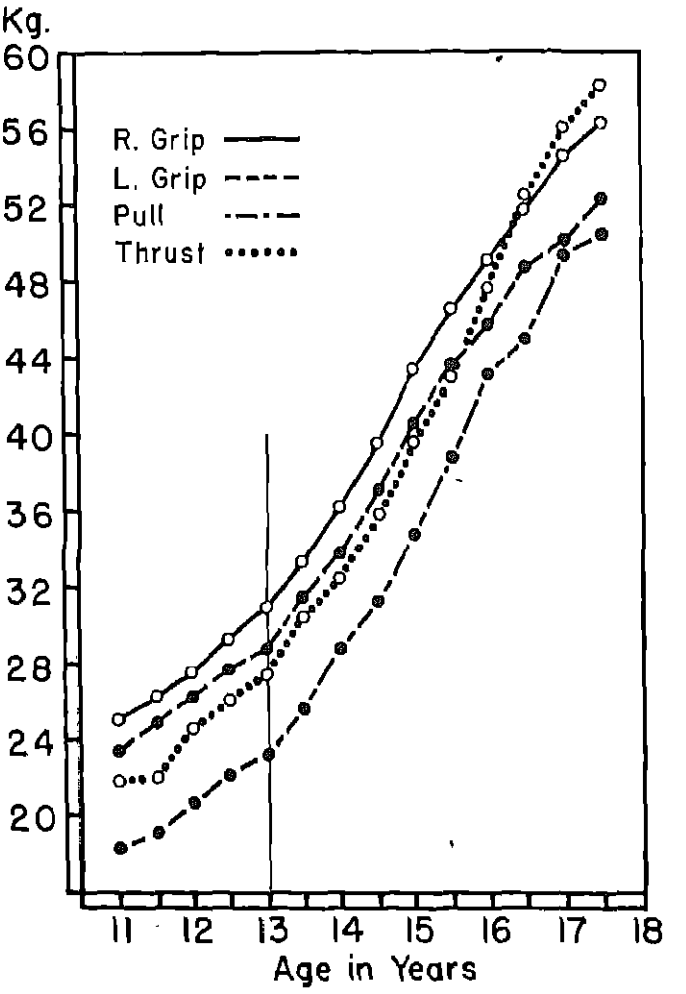

Figure 1. Average growth curves, for boys, in four functions.

sample consists of boys from the Adolescent Growth Study (4, 5) at the University of California, a normal sampling of cases from the Oakland Public Schools.

The curves in Figure 1 agree in showing an inflection at age 13. This is, clearly, the age which marks the beginning of the puberal growth spurt in strength. It is well known, however, that puberty occurs at different ages in different individuals. If the timing of the growth spurt is influenced by sexual maturity, it is probable that individual curves will diverge widely

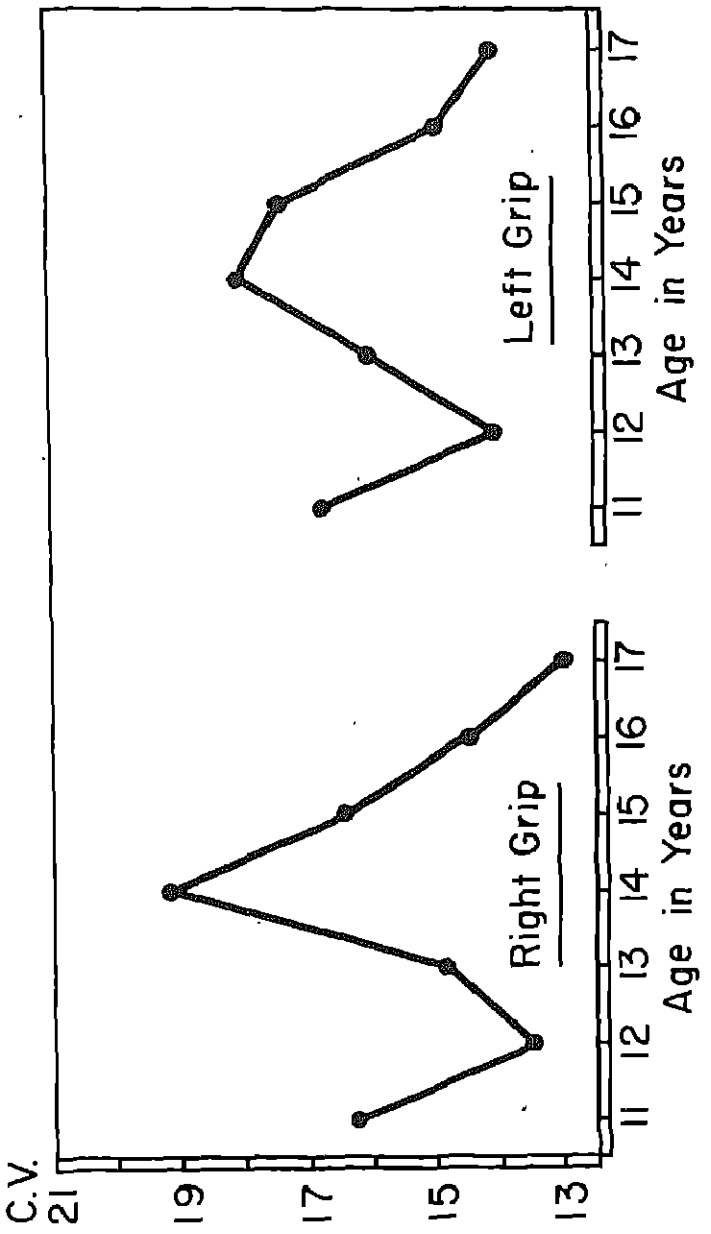

Figure 2. Age changes in the coefficient of variation for strength.

from the average curves shown in Figure 1.

The effect of such divergence should be seen, statistically, in measures of variability during the puberal period. Age changes in the coefficient of variation for strength are shown in Figure 2. Relative to the mean, the standard deviation declines from age 11 to 12; this is followed by an acceleration until a peak variability is reached at 14 years. It may be assumed that the recession after 14 represents a return to more normal variability, as an increasing majority of cases complete their growth spurt. The results reported here are similar to those previously found by Meredith (8) for Grip Strength. However, the hypothesis that changes in relative variability are produced by variable rates of maturing requires for its verification longitudinal records rather than the cross-sectional data employed by Meredith.

In the present sample, measurements of maturing are available in terms of x-ray measurements[3] of the hand and knee. In examining the effects of early and late maturing, average growth curves were prepared for boys classified in three groups as precocious, average, or retarded. The precocious and retarded are of course not a clinic sample; they represent approximately

TABLE 2

MEAN SCORES FOR EARLY, AVERAGE AND LATE MATURING (Kg., Right Grip)

Age	Early	Av.	Late
N:	16	28	16
11.0	27.1	24.0	22.7
11.5	29.3	25.9	25.2
12.0	29.3	26.9	26.0
12.5	31.3	28.4	27.0
13.0	33.3	30.4	28.1
13.5	37.6	32.5	30.0
14.0	44.2	34.3	30.2
14.5	47.1	38.6	33.3
15.0	50.0	43.0	36.3
15.5	52.2	47.6	41.1
16.0	54.3	49.0	43.9
16.5	55.9	50.9	48.4
17.0	57.2	53.5	51.5
17.5	--	55.8	54.3

[3]*These were made by Dr. Nancy Bayley. The method is described in (1).*

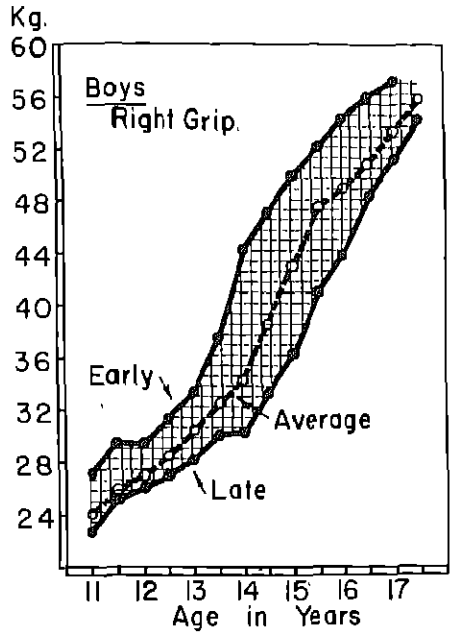

Figure 3. Growth curves for early-, average, and late-maturing boys, classified on the basis of skeletal ages.

the 20 percent at each extreme of a normal public school distribution. The "average" group consists of approximately the middle third of the cases, whose skeletal ages between 14 and 16 years coincided closely with the norms for boys of the same chronological ages.

The results are shown in Table 2 and Figure 3. It is apparent that in choosing different maturity groups we have obtained different strength groups as well. The differences between the early and late groups are significant at the 1 percent level.[4] The curves in Figure 3 are more or less parallel, with some divergence of the early- and late-maturing groups between the ages of 13 and 15, and with a later convergence which, however, fails to bring them together at the end of the series of measures.

[4] *At age 11, t = 3.6 (with 30 d.f.). At age 14.5, the time of maximum difference, t = 9.2. S.D.s for the early and late groups are 3.5 and 3.2 respectively at age 11; 7.8 and 6.1 respectively at age 14.5.*

TABLE 3

MEAN STANDARD SCORES FOR EARLY- AND LATE-MATURING BOYS (Right Grip)

Age	Early	Late
N:	16	16
11.0	55.2	44.4
12.0	55.1	45.1
13.0	56.1	44.3
14.0	61.7	41.7
15.0	58.5	40.7
16.0	57.4	43.4
17.0	53.9	45.5

Attention may be called to the fact that in this same sample of boys, the early-maturing are also larger in physical size than the late-maturing, at all ages from 11.7 to 17.7 years.[5] From the Harvard Growth Study, Shuttleworth (9) has reported that early-maturing boys (classified in terms of age at maximum growth) are superior in size to late-maturing boys. The difference in size is apparent as early as six years, and is maintained to the terminal measurements at 18 years.

It is unfortunate that, as yet, our data on strength do not extend to age 20 and beyond. However, in view of the tendency for the early-maturing to include more individuals of athletic (mesomorphic) build, and also in view of the tendency for earliness in maturing to be a factor in the development and maintenance of more athletic habits, it is highly probable that some average difference would be found to remain at adult ages.

The association of muscular strength and adolescent "status" is well known (6). Because of this relationship, it seems desirable to examine the growth of each maturity group in relation

[5]Reference 2. See Figures 12-15, in this reference, for growth curves of height, stem length, bi-iliac diameter, and bi-acromial diameter. These growth curves, for early-, average, and late-maturing boys, are very similar in appearance to those for Right Grip.

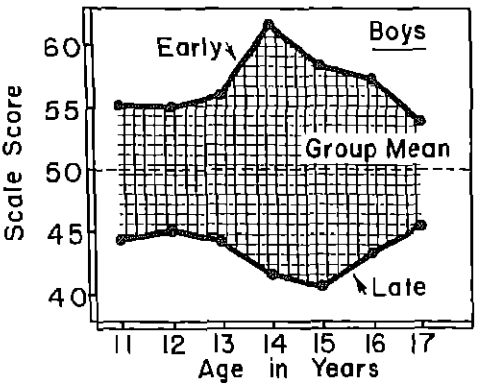

Figure 4. Standard score curves (right grip) for early- and late-maturing boys.

to the total group of boys of the same ages. Relative strength levels, and changes in these levels, are brought out more clearly when the strength scores in physical units are transformed into scale scores (relative to a group mean of 50, and a group S.D. of 10). This has been done in Table 3 and in Figure 4, presenting scale scores for the two extreme groups at annual intervals; in these curves, a rising line indicates a growth rate more rapid than the average, a falling line indicates a decelerating growth rate, relative to the average of that age.

The convex-concave form of curves for the early- and late-maturing cases provides a clear representation of contrasting growth patterns. As was shown in Figure 3, the early-maturing boys stand at all ages above the average.[6] But here more distinctly than in Figure 3, we note (among the early-maturing) an upward trend in relative growth rate from 13 to 14 years, with a peak at 14. The late-maturing, on the other hand, show a decline, relative to the average between the ages of 12 and 15; this is followed by a growth spurt, with a return toward the average after 15. At the beginning, and again at the end of the adolescent period, the early- and late-maturing boys are sepa-

[6] *Differences in Figures 3 and 4 in the position of the "average" line between the early and late maturing are due to the fact that in Figure 3 the average is based on a "typical" or "middle" sample whereas in Figure 4 the average is the mean of the total group.*

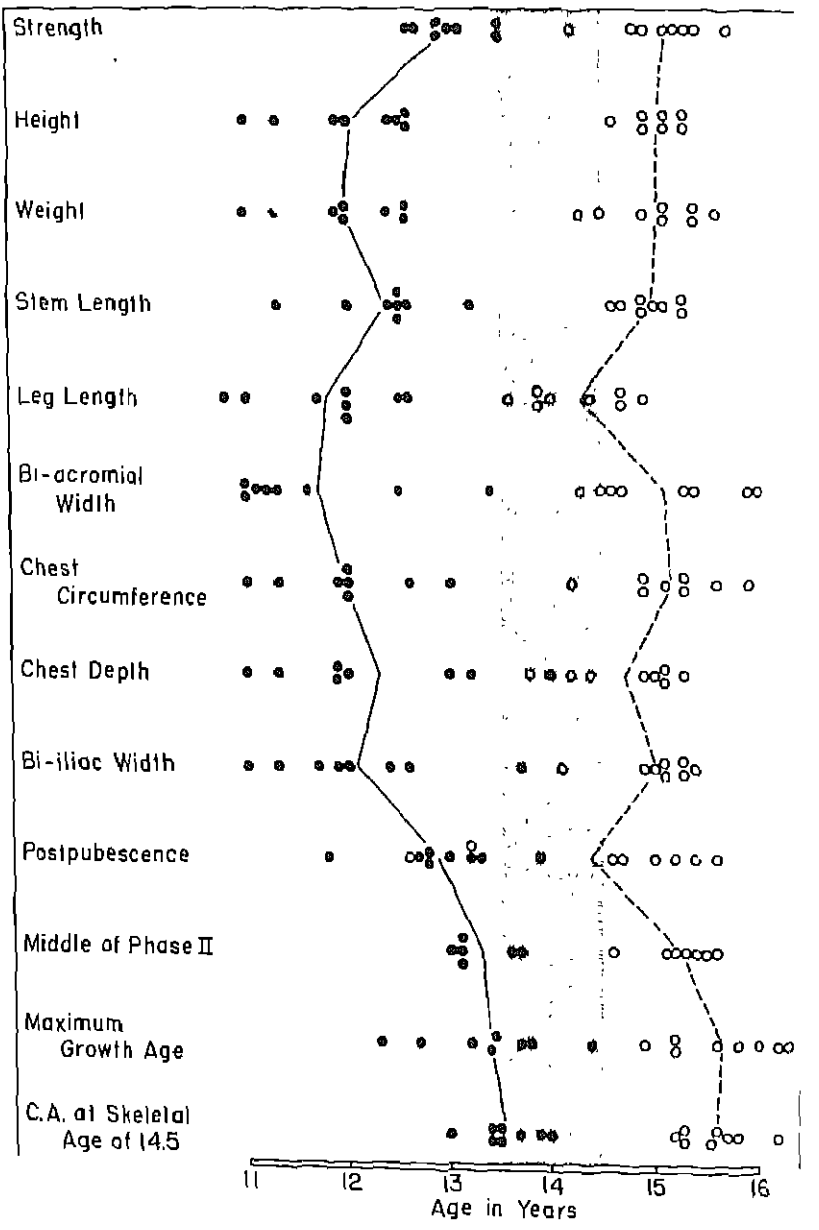

Figure 5. Profiles for maturity indices: Early- and late-maturing boys.

ɔy about 1 S.D., but in the middle of the period, when the
' have received the full benefit of their earlier growth
s, the difference between the two groups becomes as
s 2 S.D., and can hardly fail to find representation in the
related to strength.

further study of growth curve relationships, eight cases
ɪ extreme in the skeletal maturity classifications were
ɛd for comparison as to a number of other criteria of
ng. These cases were a random selection of early- and
aturing boys who had consecutive records from 11 to 16
or later. Figure 5 presents this comparison in terms of
e of inception of the growth spurt in strength[7] and in a
of physical measurements.[8]

ge of inception" was determined from the individual scale
curves, which usually show a clearer definition of short-
growth phases than is apparent in the average curves. In
instances the growth pattern is poorly differentiated, or
ɛn disturbed to a confusing degree by such factors as
al variations. A further limitation lies in the fact that
asurements were taken only twice a year. Nevertheless,
rly- and late-maturing boys (selected solely on the basis
ɪrity assessments of skeletal x-rays) prove to be sharply
ninated in the age of incidence of the growth spurt for
th and for the various size measurements. If the growth
had been more reliably determined (on the basis of more
nt cumulative records) it is probable that each group
show greater homogeneity in each variable, and that the
oups would be even more distinct than now appears to be
se. The most clear-cut, non-overlapping differentiation
he growth spurts for height and weight, which are also
aracteristics most reliably measured. Bi-acromial and
c width, and chest circumference and depth are less re-

*determining the growth spurt for strength, independent as-
ɪts were made and averaged for the four aspects of strength
and Left Grip, Pull, Thrust).*

*em length (the distance from prominence of the tuber ischii
wn of the head) is a measure of the length of the trunk and
obtained when the subject is sitting with his back against
ical measuring board, his spine being forced into relatively
al position by bending the knees so that the thigh is at a
gle from the floor. Leg length was determined by subtract-
em length from total height.*

*-acromial (shoulder) width and bi-iliac (hip) width are
ined by means of sliding calipers applied, respectively, to
romial points on the shoulders and the iliac crests on the*

liably measured, and no doubt this accounts at least in part for the poorer separation of the groups with respect to these variables.

In a study of the total sample of 93 boys from which these extreme groups were selected, Stolz (10) has shown that in the timing of growth spurts (the beginning of "Phase II" of the puberal cycle) a sequence can be recognized in which growth in leg length comes first, followed by bi-acromial and bi-iliac width, stem length, and strength. Among both the early- and the late-maturing, leg length clearly shows a growth spurt earlier than stem length or strength (among the individual records, this is evident in 13 of the 16 cases). The lag in the growth of strength is, however, more conspicuous among the early- than among the late-maturing. The latter tends to be "as strong as he looks." The former, at the age of 12 and 13, is not so strong as his height and weight would lead one to expect; nearly a year may elapse before functional efficiency, as manifested in strength, catches up with changes in size.

It has previously been noted (9) that the early-maturing tend to have a more sharply defined growth pattern than the late-maturing, i.e., their growth rates are greater at the peak of growth, and their phase changes in growth tend to be more sudden and more distinct. It is not surprising that they are subject to more marked discrepancies in the growth of different parts of the body, or in functional development (e.g. strength) as compared with the development of gross bodily structures.

The late-maturing, growing over a longer period, and with more gradual changes, may more readily succeed in adapting the various aspects of growth to each other, and in maintaining balance or congruence in physical development. Where such is the case, they escape some of the strains incident to early and rapid growth. This may not, however, compensate for the fact already noted that during several years in adolescence the late-maturing individual is so slow in realizing his physical potentialities that he tends to be handicapped in athletic competition and in status-relationships with others of the same age.

In addition to the variables discussed above, Figure 5 presents a comparison of the two groups of boys on four measures which are often used in assessing maturity. The first of these, "Postpubescence," is determined by the first appearance in the pubic region of terminal hair which is fully pigmented and which is marked by a wave or kink. Since the early studies of physiological age by Crampton (3), this criterion has been widely applied in classifying the physiological maturity of boys. It is apparent, however, that it fails to define our two groups satisfactorily; two individuals who are by all other indications late-

maturing fall among the early-maturing in their pubic hair ratings. It is also apparent that the development of pubic hair is influenced by factors other than those directly concerned in the maturing of body size. Among the early-maturing in this sample, postpubescence comes later than the inception of pubertal growth in, for example, height and weight; among the late-maturing, on the other hand, it tends to accompany or even to precede the growth spurt in these variables. The physiological basis of such differences remains to be demonstrated, but it is apparent that factors associated with timing play an important role in the pattern of endocrine stimulation, as manifested in both (a) linear and ponderal growth and (b) the development of secondary sexual characteristics.

The "Middle of Phase II" is determined from assessments made by Stolz (10), based on the growth pattern for stem length and on accessory indications from the growth of the external genitals. For the total group of 93 boys, Phase II begins on the average at (approximately) 13 years, continuing to 16, with a middle point at 14.5. For the six early-maturing and seven late-maturing boys to whom this classification could be applied, the middle of Phase II falls respectively at 13.3 and at 15.1 years, and the two groups are well separated.

If, instead of the Phase diagnosis (which requires experience in assessing related data), the classification is made merely in terms of the mid-point of the age period in which the most rapid growth occurs in stem length, we obtain the results shown under "Maximum Growth Age," (on the average 13.4 years in the early-maturing, 15.7 in the late-maturing). Shuttleworth (9) has applied the maximum growth age (MGA) technique to various physical dimensions, with considerable success in discriminating groups of differing maturity. In the present sample, it is apparent that this criterion separates the early and late maturing into non-overlapping distributions, but each group is less homogeneous than might be desired. Inspection of Figure 5 indicates that a greater homogeneity, within each of the contrasting groups, is obtained by the Phase Criterion, and also by the growth spurt criterion in strength.

The final measure in this series, the chronological age at which a skeletal age of 14.5 was attained, should be expected to yield a good separation of the groups, since it is a part of the series of x-ray measurements on the basis of which the groups were originally segregated. In each group the Maximum Growth Age falls close to the time when a Skeletal Age of 14.5 is attained, no matter what the chronological age may be.

The inception of the adolescent growth spurt in strength occurs slightly earlier, at an average Skeletal Age of about 14.

The early-maturing are at this time 13 years old, on the average. It was shown in Figure 1 that the inflection in the strength growth curve for the total group occurs at 13 years. We now see that this is due to the contribution of early-maturing individuals in the group, and does not indicate that the average-maturing individual begins to grow rapidly in strength at this age. His inception point is more likely to be at 14, when his Skeletal Age is also 14.

SUMMARY

1. Average growth curves, from age 11 to age 17.5 years, were presented for four aspects of static dynamometric strength. Average curves, for boys, were approximately linear from 11 to 13 years, with an inflection to a more rapid rate of growth after 13.

2. Changes in homogeneity of the group, attributed to individual differences in rate of maturing, were shown by increases in the coefficients of variation between the ages of 12 and 14. This was followed by a decrease, as an increasing majority of cases completed their growth spurt.

3. The effects of differential maturing upon growth in strength were examined by comparing the growth curves of boys classified (on the basis of skeletal x-rays) as somewhat precocious, average or somewhat retarded. The early-maturing were significantly stronger than the late-maturing at age 11; their superiority continued until the terminal measurements at 17.5.

4. A comparison of the early- and late-maturing groups in terms of standard scores illustrated characteristic differences in relative growth patterns. The early-maturing showed an upward trend in relative growth rate from 13 to 14 years, followed by a decline. The late-maturing showed a lag, relative to the average, between the ages of 12 and 15, with a growth spurt after 15.

5. In a more detailed comparison of early- and late-maturing boys, it was found that among the former (but not the latter) the age of inception of puberal growth was later for strength than for most physical measurements. It was inferred that the more gradual nature of physical growth in the late-maturing permits a closer synchronization with physical aspects. The early-maturing experience more rapid, and in some respects less well integrated growth changes, but they often gain an early advantage in athletic competition and in associated prestige.

6. When the inception of puberal growth in strength is related to other criteria of maturity, it is found to occur at a

skeletal age of approximately 14 years (Todd). In both the early- and late-maturing it comes slightly after the first signs of postpubescence (Crampton), slightly before the middle of Phase II (Stolz), and about half a year before the maximum growth age in height (Shuttleworth). The discrimination of skeletally early- and late-maturing groups is clearest in the puberal spurts for strength, height and weight, and in the determinations of Phase II; it is least adequate in the assessments of postpubescence, suggesting a more limited validity of the latter measure in the determination of physiological age.

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AN ANALYSIS OF FOOD CONSUMPTION AND PREFERENCES OF NURSERY SCHOOL CHILDREN[1]

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Introduction

With conscription of young Americans for the armed forces of the United States came the realization that the youth of the country are not in prime physical condition. This fact does not harmonize with the great abundance and variety of food produced in this country.

Authorities attribute the sub-optimum physical condition of American youth in a large measure to inadequate diet. Inadequate diet includes both the problem of the right kind and that of sufficient quantity of food. Much work is being devoted to determining what Americans are doing with their food supply; that is, what they are serving their families, what their likes and dislikes are, what the practices of handling foods in the home are, and similar problems. Additional investigations are being conducted on the effect of the food supply on the nutritional status of Americans; namely, what the concentration of nutrients in the blood stream is, what relationship exists between the food intake and the nutritional status of the person, what criteria we have for measuring early signs of nutritional inadequacy, what other factors besides food intake affect the nutritional status and physical development of a person.

That no adult can attain a higher state of physical fitness than his early developmental history permits is an established

[1]*This investigation was made possible through grants from the Research Fund of Texas Technological College.*

The study is a part of the comprehensive research entitled "The psychophysical development of the preschool child." Three parts of this research have been published: (1) Lamb, M. W. Basal metabolism of eight nursery school children determined at three-month intervals. Am. J. Dis. Child. 70, 220-225, 1945. (2) Ling, B. C. The solving of problem-situations by the preschool child. J. Genet. Psychol. 68, 3-28, 1946. (3) Ling, B. C. The adaptation of the preschool child to standard basal metabolism conditions. J. Genet. Psychol. 68, 29-44, 1946. Other parts are in preparation. When completed, the entire research will be published as a unit.

fact. Physical handicaps developed from malnutrition in childhood cannot be overcome completely but will show their effect at various times during adulthood. Furthermore, health records of adults show that their sub-optimum physical condition is not the result of their immediate practices but rather of the accumulation of long-time abuses. The poor teeth, imperfect eye sight, and prevalence of infectious conditions recorded in the examinations of conscriptees are not the result of dietary and health practices of the previous month, but can be attributed to inadequate dietaries and health habits of childhood. One must, therefore, understand the nutritional practices of the child in order to understand better the physical state of the adult and the probable causes for deviations from the optimum.

Purpose

The following study is an attempt to gain insight into the nutritional practices of the child by analyzing his food consumption and preferences. It is fivefold in its purpose.

1. To determine the food consumption and nutrient intake of normal nursery school children.
2. To determine the adequacy of these intakes by comparison with accepted dietary standards for these subjects.
3. To study the food preferences of these subjects by analyzing their affective concomitant during food intake.
4. To study the influences of the food preferences on the adequacy of their diet.
5. To observe any relationship between the food consumption and the results of pediatric and dental examinations made on these subjects.

Experimental Procedure

The subjects were 8 children, 5 boys and 3 girls, from the Nursery School of the Department of Child Development in the Division of Home Economics of Texas Technological College. They were selected at random from applications for admittance to the Nursery School. Their ages ranged from 2 years, 2 months to 3 years, 7 months. They were normal healthy children from homes varied in living standards, yet limited to the so-called middle class of citizenry.

The mothers and nurses of the subjects were informed in advance of the plans of the study and instructed in the recommended procedure for keeping records in order to insure uniformity of data and whole-hearted cooperation. Standard equipment accurate to a fourth of a teaspoon was furnished to

measure the food consumed by the subjects both at home and in the Nursery School. No control was exercised over the menus used in the feeding of each subject.

Daily records, both of food consumed and of affective concomitant during the food intake, were kept for one week at 3-month intervals starting October 7, 1942 and ending October 20, 1943. The food-intake records include the amounts of food consumed as well as the ingredients used in the preparation of "made-dishes."[2] The affective concomitant data classify the emotional responses of the subjects to each dish into the following 5 categories:

1. VP = very pleasant, when the child expressed his hearty approval of the dish by exclamations of joy upon seeing and tasting it, by consuming the content with alacrity, and often by asking for a second serving.

2. P = pleasant, when the child consumed the dish cheerfully and in good time. Sometimes the process was accompanied by such remarks of approval as "I like this." or "It's good!"

3. N = neutral, when the child ingested the food upon request. He showed neither signs of relish nor those of protest. He was matter-of-fact in the process.

4. U = unpleasant, when the child consumed the food only under protest. Often he dawdled and refused to empty the dish. Such utterances as "I don't like this." or "I am full." were common.

5. VU = very unpleasant, when the child refused completely to taste the food. If urged, he tended to show strong emotional outbursts. If left alone, he might sit by the hour before the dish without attempting to consume it.

In this connection it is important to note that the subjects did not have before them a whole array of dishes from which to choose during any meal. What they were to eat was prescribed by their mothers or nurses while at home and by teachers and cook while at the Nursery School. However, they were free to express their preference for a given dish by their affective concomitant during the consumption of that dish. It may also be well to point out here, by way of emphasis, that the assignment of any of the 5 types of affective concomitant to a given reaction to a specific dish was based upon the total behavior pattern of the subject.

At home the mother or the nurse of the subject served as observer and recorder. In the Nursery School one of the experimenters took charge of affective concomitant records for all

[2] *By "made-dishes" is meant all those dishes prepared by a combination of various foods not specified in standard recipes.*

subjects, while student assistants, under careful supervision of the other experimenter, measured as well as recorded the food consumed. Both types of records were checked for their specificity and accuracy at the close of each experimental week.

Occasionally record taking for a subject had to be postponed for a few days because he was ill or out of town. At the completion of the third experimental week Cases IV and VIII left town, while the mother of Case II discontinued her participation in the project because she found the task too tedious. Thus, 3 subjects had only 3 weekly food consumption and affective concomitant records, whereas 5 completed the study with 5 records each.

Heights and weights of the subjects were recorded to the nearest tenth of an inch and of a pound[3] respectively for each experimental week. Dental and pediatric examinations were made by experts in those professions[4] in November, 1942, April, 1943, and January, 1944. These records were kept in order to ascertain the well-being of each subject throughout the entire study.

Treatment of Data

I. Food consumption records

Data on the amounts of food consumed by each subject were compiled for each weekly period, and the nutritive value was calculated according to average compositions given by Taylor (1). The nutritive value of "made-dishes" not given by Taylor was computed on the basis of percentages of the ingredients in the dish. No consideration was given to the influence of the area of the country on the amounts of nutrients in foods or on practices of preparation.

The average weekly food intake of the subjects was obtained by classifying the foods into 11 groups[5] and by compiling the weights of foods in each class for each of the 5 experimental weeks. All 5 of the weekly food-group intake records were

[3] *These measurements were converted to centimeters and kilograms respectively.*

[4] *Dr. G. C. Turner, orthodontist, and Dr. W. C. Overton, head pediatrician of Lubbock General Hospital, were kind enough to examine the subjects at the intervals specified by the experimenters.*

[5] *These groups are those used in the weekly Family Food Plans as published by the U. S. Dept. Agric. AWI-78, 1943.*

averaged for each subject for the experimental year.

II. Affective concomitant records

Data on the affective concomitant of the subjects during the food intake were analyzed first on the basis of preference and then on the basis of learning. To attain the former objective all the dishes consumed by the subjects were classified into 13 major divisions; namely, (1) meats, (2) fish, (3) fowl, (4) eggs, (5) dairy products, (6) vegetables, (7) fruits, (8) cereal products, (9) food combinations, (10) custards, puddings, and gelatin desserts, (11) concentrated sweets, (12) pharmaceutics, and (13) miscellaneous food items. Each of these major divisions was then further divided into subdivisions, groups, subgroups, and units. Every food item within the same unit was analyzed according to the methods employed in the preparation and the ways of serving it. At every step of the classification the affective responses of each subject were compared among themselves, as well as with those of the other subjects, in order to ascertain both individual and group reactions to food in general, to a specific class of food, to a specific food item, to a specific dish, and to a specific way of serving that dish.

To analyze the learning process involved in the food preference of the subjects the affective concomitant data were compiled for the group for each of the 5 experimental weeks. Then all the food consumed by each subject during each week was treated, first as a unit, later under the 13 major food divisions. Finally, the affective response of each subject to any dish which had appeared more than once in his weekly menus over two or more experimental weeks was analyzed in order to determine different types of learning involved.

In order to compare the relative acceptability of two or more dishes, food items, or divisions to a given subject or to the entire experimental group, two very simple methods of computation were devised. The first was called the percentage of frequency method. In it the number of times in which a particular dish (or food division) was judged very pleasant, pleasant, neutral, unpleasant, or very unpleasant was divided by the total number of times in which that particular dish (or food division) was served to the subject (or the experimental group). The result thus obtained was then compared with that of another dish (or food division) similarly treated.

The second method was referred to as the rank score method. It consisted of 4 steps:

Step 1. Assuming that the degree of affection between any two members of the 5 types of affective concomitant was equal,

numerical values were assigned as follows:

VP = 1
P = 2
N = 3
U = 4
VU = 5

Step 2. Each of the numbers obtained in Step 1 was multiplied by the frequency with which a given dish (food item or division) was judged very pleasant, pleasant, neutral, unpleasant, or very unpleasant.

Step 3. All the products obtained in Step 2 were added.

Step 4. The sum just obtained was divided by the total frequency with which the dish (or food division) in question appeared in the dietary of a given subject (or of the entire experimental group). The quotient was the rank score for that food for the subject or subjects under consideration.

A rank score obtained by the above method of computation does not only indicate the relative acceptability of one food as compared with another, but it also gives an accurate estimation of its absolute acceptability. For instance, a rank score of 1.20 means that the food in question is judged not only as much more acceptable than another food having a rank score of 3.50, but is, on the whole, very pleasant to the subject or subjects concerned.

III. Physical status records

From the data on the heights and weights of each subject throughout the experimental period the normalcy of his weight for his height and age, according to the standard developed by Woodbury (2) was determined. For children, normalcy of weight means their weight coming within plus or minus 10 to 15 percent of the average weight for his height and age. The dental and pediatric examination records were analyzed and those parts related to the nutritional status of the subject correlated qualitatively with the results on food consumption and preferences.

Results

I. Food consumption

A. Consumption of individual nutrients

A study of the average daily nutrient intake of the subjects recorded in Table 1 brings out the following impressive facts:

1. Large quantities of vitamins and mineral elements are

TABLE I

AVERAGE DAILY CONSUMPTION OF NUTRIENTS AS CALCULATED FROM ONE WEEK'S DIETARY TAKEN FOR A YEAR AT THREE-MONTH INTERVALS

Case	Sex	Age	Average daily consumption of nutrients: Calories	Protein	Calcium	Iron	Vitamin A	Thiamine	Riboflavin	Absorbic acid
		yr. mo.		gm.	gm.	mg.	I.U.	mg.	mg.	mg.
I	F	2 2	1063	44.9	1.40	6.0	3,052	0.51	2.38	96
		2 5	1158	48.9	1.61	7.0	18,018*	1.00	3.83	84
		2 8	1068	39.1	1.09	5.9	15,645*	0.42	2.15	76
		2 11	1061	43.7	1.17	4.7	3,118	0.63	2.18	64
		3 2	1106	43.1	1.06	5.5	3,572	0.76	2.06	75
		Average	1091	43.9	1.32	5.8	8,681	0.66	2.52	79
II	M	3 3	1287	52.1	1.29	36.8*	22,802*	1.39	3.02	129
		3 6	1205	49.1	1.23	7.0	16,311*	0.89	2.49	118
		3 9	1186	49.1	1.25	5.9	20,535*	0.81	2.45	107
		Average	1226	50.1	1.26	16.6	19,883	1.03	2.65	118
III	M	3 7	1023	47.8	0.59	6.5	4,684	0.75	1.31	113
		3 10	1079	45.1	0.73	8.8	4,316	0.83	1.63	103
		4 1	1416	55.4	1.13	7.7	5,753	0.98	2.20	94
		Average	1173	49.4	0.82	7.7	4,918	0.85	1.71	103
IV	F	3 5	1373	40.4	0.80	7.1	8,936*	0.66	1.83	62
		3 8	1181	41.7	1.00	7.4	7,005*	0.81	2.00	91
		3 11	1414	48.0	1.10	7.9	5,504	0.86	2.15	80
		4 2	1371	51.8	1.17	6.7	4,398	0.70	2.19	39
		4 5	1529	52.8	1.35	7.2	5,617	0.83	2.59	70
		Average	1374	46.9	1.08	7.3	6,292	0.77	2.15	68
V	F	3 3	1113	43.0	0.87	5.3	3,338	0.68	1.73	85
		3 6	1101	47.1	0.77	6.5	22,144*	0.76	1.93	98
		3 9	1058	45.2	0.92	6.3	8,984*	0.72	1.90	74
		4 0	1041	40.1	0.86	5.3	11,828*	0.60	1.72	41
		4 3	1076	44.2	0.82	6.1	4,115	0.76	1.85	41
		Average	1078	43.9	0.87	5.9	10,082	0.70	1.83	68
VI	M	3 4	1169	56.6	0.81	7.4	3,838	0.98	1.70	49
		3 7	1137	45.5	0.93	7.5	4,295	0.84	1.87	99
		3 10	1112	41.6	0.97	6.6	5,281	0.80	1.95	72
		4 1	1447	60.4	1.18	10.0	4,484	1.08	2.86	52
		4 4	1223	50.1	1.01	7.9	4,252	0.81	2.07	79
		Average	1217	50.8	0.98	7.9	4,430	0.90	2.09	70
VII	M	3 6	1400	42.9	1.11	10.2	15,186*	0.95	2.58	58
		3 9	1035	41.2	0.98	6.9	4,449	0.81	1.99	114
		4 0	1283	31.6	1.17	7.5	4,244	0.83	2.34	73
		4 3	1323	54.1	1.11	7.5	7,481	0.73	2.10	39
		4 6	1392	44.3	0.99	6.7	4,729	0.72	2.05	57
		Average	1287	42.8	1.07	7.8	7,218	0.81	2.21	68
VIII	M	3 3	1425	50.5	1.49*	10.5	3,831	0.88	0.92	128
		3 6	1929	58.7	1.50*	12.1	21,256*	1.18	1.15	\122
		3 9	1921	128.0	0.45	11.0	5,947	1.14	1.23	158
		Average	1425	79.1	1.15	11.2	10,345	1.07	1.10	136
Standard: Recommended daily allowances by the National Research Council, revised, 1945.										
		1-3 yrs. 1200 to		40-50	1.0	7-8	2,000	0.6	0.9	35-50
		4-6 yrs. 1600					2,500	0.8	1.2	

*Concentrate of nutrient given.

TABLE 2

AVERAGE WEEKLY FOOD CONSUMPTION OF SUBJECTS

Kinds and quantities of food consumed per week

Case	Sex	Age		Milk	Potatoes, sweet & white		Dry beans peas, & nuts		Citrus fruits, tomatoes		Green & yellow vegetables		Other vegetables & fruits		All meats		Cereal products		Fats		Sugar products		Eggs
		yr.	mo.	qt.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	lb.	oz.	no
I	F	2	2	7	0	3		0	0	12	0	5	[illegible]	7	0	12	0	11		0		0	[illegible]
		2	5	8	0	3		0	1	9	0	[illegible]	1	[illegible]	0	6	0	10	0	[illegible]	0	[illegible]	[illegible]
		2	8	6	0	3		0	1	6	[illegible]	11	[illegible]	[illegible]	0	5	[illegible]	11	0	[illegible]	0	[illegible]	[illegible]
		2	11	6 3/4	0	3		0	1	5	[illegible]	[illegible]	0	7	0	8	0	13	0	[illegible]	0	[illegible]	[illegible]
		3	2	5 3/4	0	5		0	2	1	[illegible]	4	[illegible]	[illegible]	0	11	0	12		[illegible]		7	[illegible]
		Average		6.7	0	3.4			1	6.4	0	7.2	1	7.8	0	8.4	0	11.1	0	[illegible]	0	[illegible]	5.5
II	M	3	3	6 3/4	0	5		0	[illegible]	5	0	13	[illegible]	10	[illegible]	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		3	6	6 1/2	0	5		0	[illegible]	14	0	8	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		3	9	5 3/4	0	5		0	[illegible]	4	0	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Average		6.7	0	5.0			2	[illegible]	0	8.0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
III	M	3	7	9	0	2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	10	[illegible] 3/4	0	6	0	[illegible]	[illegible]	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		4	[illegible]	6	0	9		0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4
		Average		6.5	0	5.7	0	[illegible]	[illegible]	[illegible]	0	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IV	F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Average		5.4	0	7.4			1	[illegible]	0	[illegible]	1	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
V	F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Average		4.5	0	3.8	0	0.4	1	12.6	0	[illegible]	1	[illegible]	0	[illegible]	1	7.2	0	[illegible]	0	[illegible]	5.0

TABLE 2 - (Continued)

AVERAGE WEEKLY FOOD CONSUMPTION OF SUBJECTS

Kinds and quantities of food consumed per week

Case	Ser	Age	Milk	Potatoes, sweet & white	Dry beans peas, & nuts	Citrus fruits, tomatoes	Green & yellow vegetables	Other vegetables & fruits	All meats	Cereal products	Fats	Sugar products	Eggs
		yr. mo.	qt.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	no
VI	M	3 4	4 1/2	0 3	0	1 1	0 2	1 12	0 13	1 15	0 2	0 1	4
		3 7	5	0 7	0	3 1	0 3	1 14	0 14	2 1	0 3	0	2
		3 10	5 1/4	0 5	0	1 15	0 5	1 4	0 8	2 8	0 2	0	1
		4 1	5 1/4	0 9	0 4	0 11	0 11	2 0	1 4	1 4	0 2	0	4
		4 4	5 1/4	0 6	0 1	2 2	0 7	0 12	1 3	1 10	0 1	0	2
		Average	5.2	0 6.0	0 1.0	1 12.4	0 5.6	1 3.8	0 14.8	1 14.0	0 2.0	0 0.2	2.6
VII	M	3 6	5 1/4	0 9	0	1 9	0 9	1 2	0 11	1 7	0 1	0 9	1 1/2
		3 9	5	1 3	0 3	3 5	0 4	2 4	0 8	0 15	0 1	0 1	
		4 0	5 3/4	0 10	0	1 9	0 6	3 12	0 8	1 1	0 2	0 3	3
		4 3	5 3/4	0 7	0	1 1	0 10	0 15	1 5	1 9	0 2	0 5	3
		4 6	5	0 8	0 1	1 3	0 9	1 15	0 9	1 6	0 2	0 15	2
		Average	5.3	0 10.6	0 0.8	1 11.8	0 7.6	2 0.0	0 11.4	1 4.4	0 1.6	0 6.6	1.9
VIII*	M	3 3	7/8	1 7	0 1	3 3	0 10	3 9	0 3	2 5	0 3	0 4	8
		3 6	1/16	1 10	0	3 2	0 11	2 4	1 15	3 10	0	0 1	8
		3 9	3/4	1 0	0	4 1	0 8	2 4	1 9	2 12	0 1	0 4	12
		Average	0.6	1 5.7	0 0.3	3 7.3	0 3.7	2 14.3	1 3.7	2 14.3	0 1.3	0 3.0	10
Average for all subjects			5.1	0 8.0	0 0.4	2 3.0	0 7.2	1 10.2	0 13.0	1 13.3	0 1.6	0 2.7	4.2
Standard**			5	0 8	— —	1 12	2 0	2 0	0 8	1 4	0 4	0 2	6

*Allergic to milk.

**Standard given in Family Food Plans, U.S. Dept. Agric. AWI-78, 1943.

given in the form of concentrates. Case VIII required calcium wafers because of his allergy to milk but the other cases were given pharmaceutics often for no particular reason. Furthermore, these concentrated nutrients were given at no particular month nor consistently throughout the year.

2. The average daily nutrient intake of the subjects for the entire experimental year was adequate except for slight deficiencies of calcium for Cases III and V and of iron for Cases I and V.

3. The nutrient intake for an individual subject was rather uniform from one experimental week to another throughout the year. Marked fluctuations were caused by the intake of pharmaceutics. Small deficiencies of a nutrient for only one experimental week are not significant as in calcium for Case IV.

B. Consumption of food groups

The data on the weekly food consumption of the subjects presented in Table 2 show that:

1. These subjects consumed comparatively small amounts of food.

2. Milk and milk product consumption in no case met the liberal daily allowance of one quart per child, although the subjects, with the exception of Cases IV and VIII, met the standard. (Case VIII was allergic to milk.)

3. The consumption of potatoes fluctuates greatly for most cases and is below standard for 6 of the 8 subjects.

4. Citrus fruit and tomato consumption is adequate for each case, giving an average consumption for all subjects well above the standard.

5. The greatest deficiency in food intake exists for green and yellow vegetables, with no subject consuming even as much as 50 percent of the standard. The average consumption of the subjects as a group for green and yellow vegetables was as low as 23 percent.

6. Only 2 of the 8 subjects consumed adequate amounts of other vegetables and fruits. The deficiency for the group was not as drastic as that for green and yellow vegetables.

7. The consumption of all kinds of meat was adequate for all subjects and more than 100 percent above the standard for Cases III and VIII.

8. The total amount of cereal products consumed by the subjects was adequate in most cases.

9. The amount of fat consumption as recorded was somewhat low, but this is not significant as the record does not include fats used in cooking.

10. The consumption of sugar products as recorded was ade-

quate. However, the amount actually consumed was probably much greater, because the quantity recorded represents only the sugar and sugar products eaten as such and not those used in food preparation.

11. Only Case VIII consumed an adequate number of eggs, whereas 4 cases consumed 50 percent or less of the standard.

TABLE 3

AFFECTIVE CONCOMITANT DURING FOOD INTAKE
ANALYSIS ON THE BASIS OF PREFERENCE
ALL FOODS COMBINED

Case	Total frequency	VP		P		VP / P		N		U		VU		V / VU	
		F*	%	F	%	F	%	F	%	F	%	F	%	F	%
I	552	175	31.70%	292	52.90%	467	84.60%	63	11.41%	20	3.62%	2	0.36%	22	3.99%
II	315 (525)**	229	72.70%	69	21.90%	298	94.60%	9	2.86%	6	1.90%	2	0.63%	8	2.54%
III	294 (490)	162	55.10%	91	30.95%	253	86.05%	31	10.54%	3	1.02%	7	2.38%	10	3.40%
IV	605	156	25.70%	205	33.88%	361	59.67%	171	28.26%	64	10.58%	9	1.49%	73	12.07%
V	455	107	23.52%	294	64.62%	401	88.13%	44	9.67%	7	1.54%	3	0.66%	10	2.20%
VI	507	220	43.39%	159	31.36%	379	74.75%	83	16.37%	32	6.31%	13	2.56%	45	8.88%
VII	534	156	29.21%	275	51.50%	431	80.71%	85	15.92%	13	2.43%	5	0.94%	18	3.37%
VIII	342 (570)	210	61.40%	95	27.78%	305	89.18%	24	7.02%	7	2.05%	6	1.75%	13	3.80%
Mean			42.85%		39.36%		82.91%		12.76%		3.68%		1.35%		5.03%
Median			37.55%		32.62		85.33%		10.98%		2.24		1.22%		3.60

*F_x frequency

**Numbers within the parentheses have been computed to make the total frequencies of Cases II, III and VIII, who had only three weekly food records instead of five, comparable to those of the other cases.

II. Affective concomitant

A. Analysis on the basis of preference

1. Table 3 gives a comprehensive picture of the affective concomitant of each subject as well as of the group as a whole during the food intake. Several general trends are clearly in-

dicated:

a. With all the subjects pleasant affective responses (VP + P) predominate over neutral and unpleasant responses combined (N + U + VU).

b. With 50 percent of the subjects pleasant affective concomitant is more prevalent than very pleasant. With the remaining 50 percent the reverse is true.

c. The entire group gives more neutral responses than unpleasant and very unpleasant responses combined.

d. With one exception very unpleasant affective concomitant is less frequent than unpleasant affective concomitant in all the subjects.

It would seem from the above facts that food consumption was a pleasurable occupation to the subjects.

TABLE 4

AFFECTIVE CONCOMITANT DURING FOOD INTAKE
ANALYSIS ON THE BASIS OF PREFERENCE
MAJOR FOOD DIVISIONS

Major Food Divisions	Central Tendencies	VP	P	VP / P	N	U	VU	U / VU
		%	%	%	%	%	%	%
A Meats	Mean	60.00/	30.09/	90.09/	6.61-	2.07/	1.21	3.28/
	Median	67.12	25.42	96.46	2.19-	0	0	1.35
B Fish	Mean	62.50	37.50	100.00	0	0	0	0
	Median	75.00	25.00	100.00	0	0	0	0
C Fowl	Mean	75.00	21.43-	96.43-	3.57/	0	0	0
	Median	100.00	0	100.00	0	0	0	0
D Eggs	Mean	48.07/	34.72/	82.79/	8.22-	7.52	1.47	8.99/
	Median	30.20	33.03	89.15	7.28-	2.09-	0	2.09-
E Dairy products	Mean	46.08-	42.06-	88.11	10.94/	0.52-	0.41	0.93-
	Median	35.98-	39.55	92.02-	7.29	0	0	0.40
F Vegetables	Mean	27.30-	43.01-	70.30/	16.68-	9.51-	3.51/	13.02
	Median	22.93	44.26-	76.67-	15.96-	5.26	3.10	8.68-
G Fruits	Mean	46.66/	37.80/	84.47-	12.12/	2.71	0.70	3.41
	Median	47.98-	35.30	88.20-	11.03-	2.03	0	2.60
H Cereal products	Mean	41.89-	38.82/	80.71-	16.27	2.22/	0.80	3.02/
	Median	35.06-	35.42-	82.18-	15.64	1.62	1.02	2.01
I Food combinations	Mean	46.19-	37.15	83.34-	11.75-	2.68/	2.24-	4.92-
	Median	44.03-	34.69	82.61-	12.90-	1.67-	0	3.39
J Custards, puddings and gelatin desserts	Mean	50.22-	43.80-	94.01/	5.99-	0	0	0
	Median	52.78	36.93	98.39-	1.62-	0	0	0
K Concentrated sweets	Mean	70.78-	25.65	96.43-	3.57/	0	0	0
	Median	100.00	0	100.00	0	0	0	0
L Pharmaceutics	Mean	14.78-	69.32	84.09	6.82	9.09	0	9.09
	Median	14.78-	69.32	84.09	6.82	9.09	0	9.09
M Miscellaneous food items	Mean	56.59	41.90-	98.49-	0	1.52-	0	1.52-
	Median	50.00	50.00	100.00	0	0	0	0

2. Table 4 shows the affective concomitant of the subjects for each of the thirteen major food divisions. From the figures the following facts may be derived:

a. Fish was unanimously and exceedingly well liked. With the exception of one isolated response, concentrated sweets, and miscellaneous items (e.g., beverages, gravies, pickles, and sauces) were also very well liked.

b. Fowl, meats, dairy products, and custards, puddings, and gelatin desserts were well liked.

c. Eggs, fruits, food combinations (e.g., salads, sandwiches, and soups) and pharmaceutics (e.g., cod liver oil, vitamin tablets, and calcium wafers) were liked.

d. Cereal products were somewhat less enthusiastically received.

e. Vegetables were definitely the least preferred of all the major food divisions.

3. A more detailed examination of each of the units and sub-units composing the 13 major food divisions revealed a multitude of interesting facts of which only the most salient will be included.

a. Meats

(1) Pork and beef were the two kinds of meat most frequently included in the children's menus. All the subjects, except Case VII, preferred pork to beef, although both kinds of meat were well liked. (The rank scores for pork and beef for the entire experimental group are 1.38+ and 1.71+ respectively.)[6]

(2) In the case of pork, bacon and ham vied with each other for popularity. The subjects were evenly divided in their preference for one or the other. On the whole, ham (rank score: 1.17+) was somewhat more popular than bacon (rank score: 1.35-). Fresh pork was definitely not as well liked as cured pork.

(3) With beef, major cuts (rank score: 1.60+) were preferred to sundry cuts (rank score: 2.03+) by all the subjects except Case V.

(4) Among major cuts the order of preference was: (1) steak (rank score: 1.19-), (2) meat loaf (rank score: 1.41+), (3) roast (rank score: 1.59-).

(5) In regard to the ways of preparing beef, that cooked with vegetables (rank score: 1.00) was preferred to that cooked by itself (rank score: 1.33+).

b. Fish

From the very limited data available it is very apparent that salmon (rank score: 1.00), trout (rank score: 1.00),

[6] *Unless otherwise stated, all the rank scores are for the entire experimental group.*

and halibut (rank score: 1.40), were all very popular, whether fresh or canned, whether fried, baked, or boiled. These were the only kinds of fish served sufficiently frequently to justify statistical treatment.

c. Fowl

The only kind of fowl served was chicken. Four methods of preparation were used. In the descending order of popularity they were (1) broiling (rank score: 1.00), (2) baking (rank score: 1.88-), (3) frying (rank score: 2.00), and (4) roasting (rank score: 3.00).

d. Eggs

The only kind used was chicken eggs. Among the various methods of preparation the commonest were deviling, scrambling, and soft-boiling. Soft-boiled eggs were the most popular (rank score: 1.64+); scrambled eggs ranked second (rank score: 1.77-); deviled eggs were the least preferred (rank score: 1.81+).

e. Dairy products

(1) Dairy products were divided into 3 subdivisions: (1) fluid milk, (2) frozen milk products, and (3) cheese. Of these, frozen milk products were the most popular (rank score: 1.11-); cheese ranked a close second (rank score: 1.20); fluid milk was the least preferred (rank score: 1.91-).

(2) Between flavored and unflavored fluid milk the former was unanimously preferred. (The rank scores are 1.77- and 2.02+ respectively.)

f. Vegetables

(1) With the exception of Case III, who showed a slight preference for green and yellow vegetables to other vegetables, all the subjects preferred other vegetables (rank score: 2.04-) to green and yellow vegetables (rank score: 2.44-). With Cases VII and VIII the preference was marked; with Cases IV and VI it was almost overwhelming; with Cases I, II, and V it was mild but present.

(2) The green and yellow vegetables were subdivided into fruits, leaves, roots, seeds, and stems. Among them seeds (rank score: 2.18-) were most popular. Fruits (rank score: 2.21+) ranked second in the order of preference. Roots (rank score: 2.26-) and stems (rank score: 2.38+) occupied the third and fourth places respectively. Leaves (rank score: 2.81-) were the least preferred of all. Individual differences in the order and degree of preference for these five groups of green and yellow vegetables were very marked.

(3) The other vegetables were subdivided into fruits, roots, seeds, stems, and stem tubers. Among them fruits and stem tubers shared the first place in popularity (rank score

for both: 1.97-). Roots (rank score: 2.09-) and seeds (rank score: 2.20) ranked third and fourth respectively in the order of preference. Stems (rank score: 2.62-) were the least liked of all. Individual differences in the order and degree of preference for these five varieties of other vegetables were very marked.

(4) There were 5 methods commonly used in the preparation of white potatoes. Among them baking (rank score: 1.66-) was the most popular, with ricing (rank score: 1.69-) a close second. Boiling (rank score: 1.77-) ranked third, while mashing (rank score: 2.10-) and creaming (rank score: 2.26+) occupied the fourth and fifth places respectively. As a group the subjects liked white potatoes, although marked individual differences in the order and degree of preference for these five methods of preparation were present.

(5) Raw tomatoes, tomato juice, and broiled fresh tomatoes were the 3 types of tomato dishes most frequently served to the subjects. Of these, raw tomatoes were the most popular (rank score: 1.79+). Tomato juice ranked a close second (rank score: 1.96+). Broiled fresh tomatoes were not so well liked (rank score: 2.27+).

g. Fruits

(1) Cases I, II, III, and VII preferred citrus to non-citrus fruits. Cases IV, V, VI, and VIII showed their preference in the opposite direction. The group as a whole liked non-citrus fruits (rank score: 1.68-) somewhat better than citrus fruits (rank score: 1.84+).

(2) Grapefruit and oranges were the only citrus fruits served. All the subjects preferred oranges (rank score: 1.77-) to grapefruit (rank score: 2.22+).

(3) Of the non-citrus fruits included in the subjects' menus, the most frequently used, listed in the descending order of preference, were: (1) grapes, including raisins (rank score: 1.32-), (2) bananas (rank score: 1.47-), (3) peaches (rank score: 1.49+), (4) apples (rank score: 1.63-), (5) pineapples (rank score: 1.78-), (6) apricots (rank score: 1.92-), and (7) plums, including prunes, (rank score: 2.37-).

h. Cereal products

(1) With the exception of Case III, all the subjects preferred refined (rank score: 1.68-) to whole-grain cereal products (rank score: 2.12+).

(2) Of refined cereal products the 4 categories most frequently included in the subjects' menus, arranged in the descending order of popularity, were: (1) cakes (rank score: 1.26+), (2) cookies (rank score: 1.35-), (3) cereals (rank score: 1.73+), and (4) breads (rank score: 1.85-).

(3) Of refined breads, quick breads were the most popular (rank score: 1.63-); crackers ranked second (rank score: 1.79-); yeast breads were the least preferred of all (rank score: 1.86-). Considering the closeness of these rank scores, it is apparent that there was little difference in popularity among the three types of refined breads.

(4) Of refined cereals the group showed a slight preference for ready-to-eat (rank score: 1.55-) to cooked cereals (rank score: 1.61+).

(5) Whole-grain cereal products were divided into 3 categories: (1) breads, (2) cereals, and (3) cookies. Only one subject, Case I, was served cookies, and she preferred them to both breads and cereals. In regard to the last two varieties of whole-grain cereal products Cases IV, VI, VII, and VIII preferred breads to cereals, while Cases I, II, III, and V preferred cereals to breads. These preferences were mild but nevertheless consistent. To the group as a whole, breads (rank score: 2.05+) were more acceptable than cereals (rank score: 2.31+).

(6) Whole-grain breads were composed of 3 subgroups: (1) crackers, (2) quick breads, and (3) yeast breads. Of these, quick breads (rank score: 1.10) were decidedly most popular; yeast breads (rank score: 2.17-) ranked second; crackers (rank score: 2.68) were least liked.

(7) Of whole-grain cereals the subjects preferred ready-to-eat (rank score: 2.05+) to cooked (rank score: 2.52-) varieties.

i. Food combinations

Four groups of food constituted this ninth major food division. In the descending order of preference they were: (1) sandwiches (rank score: 1.53-), (2) soups (rank score: 1.65-), (3) other food combinations such as stews, casseroles, croquettes, hash, succotash, and soufflés (rank score: 1.91-), and (4) salads (rank score: 1.95).

j. Custards, puddings, and gelatin desserts

Of the 3 food groups composing this tenth major food division, puddings were the most popular (rank score: 1.53-). Gelatin desserts ranked second (rank score: 1.61-). Custards were a very close third (rank score: 1.64-). All these three groups of food were pleasantly received.

k. Concentrated sweets

Concentrated sweets were of two subdivisions; namely, candies and other sweets such as jams, jellies, preserves, and honey. The former (rank score: 1.26+) was preferred to the latter (rank score: 1.50).

l. Pharmaceutics

Of the 8 children participating in the present study,

Case I alone consumed a sufficient amount and variety of pharmaceutics in undisguised forms to warrant statistical treatment of her results. Consequently, the data for this food division will not be discussed in detail in this report.

m. Miscellaneous

Beverages, gravies, sauces, and pickles were the 4 subdivisions composing the last major food division. In the order of decreasing popularity they were: (1) pickles (rank score: 1.00), (2) sauces (rank score: 1.17-), (3) beverages (rank score: 1.50), and (4) gravies (rank score: 2.00).

B. Analysis on the basis of learning[7]

1. Comparison of affective concomitant during the 5 experimental weeks

Table 5 presents the affective concomitant of the experimental group during the food intake in each of the 5 experimental weeks. It gives both the percentage of frequency for each type of affective concomitant and the rank score for the affective reaction of the group for the period. By comparing the corresponding figures in these five successive and uniformly spaced experimental weeks, one is able to derive an accurate picture of

TABLE 5

AFFECTIVE CONCOMITANT DURING FOOD INTAKE
ANALYSIS ON THE BASIS OF LEARNING
COMPARISON OF AFFECTIVE CONCOMITANT DURING FIVE EXPERIMENTAL WEEKS

Experimental week	Total frequency	VP		P		N		U		VU		Rank score
		F	%	F	%	F	%	F	%	F	%	
I	857 (551)[a]	423 (223)	49.36- (40.47%)	314 (239)	36.64- (43.38-)	65 (46)	7.58% (8.35-)	42 (36)	4.90% (6.53%)	13 (7)	1.52- (1.27%)	1.93- (1.85-)
II	895 (580)	360 (178)	40.22% (30.69-)	370 (283)	41.34% (48.77%)	112 (81)	12.51% (13.97-)	35 (27)	3.91% (4.66-)	18 (11)	2.01% (1.90-)	1.86% (1.98%)
III	839 (509)	377 (158)	44.93% (31.04%)	311 (218)	37.07- (42.83-)	118 (104)	14.06% (20.43%)	21 (19)	2.50% (3.73%)	12 (10)	1.43% (1.96%)	1.78% (2.03-)
IV	484	115	23.76%	235	48.55%	100	20.66%	31	6.40%	3	0.62-	2.12-
V	529	140	26.47-	250	47.26-	115	21.74-	23	4.35-	1	0.19-	2.05-

[a]Numbers within the parenthesis represent the quantitive data of the experimental group from which Cases II, III and VIII, who had only three weekly food records instead of five, have been excluded.

[7] *All the quantitative results presented in this part of the study have been computed both with and without the inclusion of the data from Cases II, III, and VIII, who had only three weekly food records instead of five.*

the general trends of change in affective concomitant during the food intake in the course of one year. Whether these changes were due primarily to development or to learning is beyond the scope of the study. The major task of the present writer is to describe those changes precisely and to interpret them in the light of the total behavior patterns of the subjects.

Table 5 reveals two general trends of change:

a. The rank scores reveal a tendency for the affective concomitant to become somewhat less pleasant with age. However, the change is mild.

b. The percentages of frequency show both very pleasant and very unpleasant affective concomitant to decrease, and pleasant and neutral affective concomitant to increase, with age. Unpleasant affective concomitant, however, assumes a fickle characteristic.

c. These same general trends remain unchanged when the data from Cases II, III, and VIII are excluded from the combined results.

From the above data it would seem that intense types of affective concomitant give way to more moderate types as food consumption becomes a more and more established habit with the rapidly developing preschool child.

An examination of the data of each of the subjects whose combined results compose the figures presented in Table 5 showed that within the general group trends pointed out above, individual differences are marked both in the amount and the evenness of the changes from one experimental week to another.

A more detailed analysis of the same data under each of the 13 major food divisions revealed the same general trends of change throughout the 5 experimental weeks in every division except that of pharmaceutics of which the data came almost exclusively from one subject. Here, again, marked individual deviations are found within the general group trends.

2. Types of learning[8]

By analyzing the affective concomitant of each subject during the consumption of any dish which had appeared more than

[8] *In the strict sense of the term "learning," Types 3, 4, and 5 are not learning from the standpoint of changes in affective concomitant. However, if one remembers that VP, P, N, U, and VU are relatively coarse measures of affective concomitant at best, and that in establishing criteria for determining the presence of the learning process, the total behavior pattern of the child, rather than his affective responses alone, is taken into consideration, one would probably agree with the present writer that, in a broader sense, Types 3, 4, and 5 should be regarded as learning types in food consumption.*

once in the subject's weekly menus, it was possible to piece together successions of affective responses which revealed various types of learning that the subject had adopted in response to different dishes during the entire experimental period. By means of this technique 7 types of learning have been discovered. They are: (1) positive learning, (2) negative learning, (3) pleasant affective concomitant remaining constant, (4) neutral or unpleasant affective concomitant remaining constant, (5) fickle affective concomitant, (6) negative learning succeeded by positive learning, (7) positive learning succeeded by negative learning.

TABLE 6

AFFECTIVE CONCOMITANT DURING FOOD INTAKE
ANALYSIS ON THE BASIS OF TYPES OF LEARNING
ALL FOODS COMBINED

Case	Total frequency	Frequency, percentage of frequency, and rank order	Types of learning						
			1	2	3	4	5	6	7
I	77	Frequency	16	12	26	3	5	10	5
		Percentage	20.78-	15.58/	33.77-	3.90-	6.49/	12.99-	6.49/
		Rank order	2	3	1	7	5½	4	5½
II	53	Frequency	7	5	33	0	4	3	1
		Percentage	13.21-	9.43/	62.26/	0	7.55-	5.66/	1.89-
		Rank order	2	3	1	7	4	5	6
III	49	Frequency	12	4	19	0	4	7	3
		Percentage	24.49-	8.16/	38.78-	0	8.16/	14.29-	6.12/
		Rank order	2	4½	1	7	4½	3	6
IV	90	Frequency	13	24	29	4	9	2	9
		Percentage	14.44/	26.67-	32.22/	4.44/	10.00	2.22/	10.00
		Rank order	3	2	1	6	4½	7	4½
V	74	Frequency	10	17	28	1	4	7	7
		Percentage	13.51/	22.97/	37.84-	1.35/	5.41-	9.46-	9.46-
		Rank order	3	2	1	7	6	4½	4½
VI	71	Frequency	8	13	25	5	6	8	6
		Percentage	11.27-	18.31-	35.21/	7.04/	8.45/	11.27-	8.45/
		Rank order	3½	2	1	7	5½	3½	5½
VII	69	Frequency	10	26	18	2	5	6	2
		Percentage	14.49/	37.68/	26.09-	2.90-	7.25-	8.70-	2.90-
		Rank order	3	1	2	6½	5	4	6½
VIII	59	Frequency	10	9	29	3	3	3	2
		Percentage	16.95-	15.25/	49.15/	5.08/	5.08/	5.08/	3.39-
		Rank order	2	3	1	5	5	5	7
All eight subjects	542	Frequency	86	110	207	18	40	46	35
		Percentage	15.87-	20.30-	38.19/	3.32/	7.38/	8.49-	6.46-
		Rank order	3	2	1	7	5	4	6
Cases I, IV, V, VI, & VII only	381	*Frequency*	57	92	126	15	29	33	29
		Percentage	14.96/	24.15-	33.07/	3.94-	7.61/	8.66/	7.61/
		Rank order	3	2	1	7	5½	4	5½

TABLE 7

Foods	Total Frequency	Frequency, percentage of frequency, and rank order	Types of learning 1	2	3	4	5	6	7
A Meats	36 (24)*	Frequency	8 (4)	[illegible] (8)	[illegible]	[illegible] (3)	5 (4)	[illegible]	[illegible]
		Percentage	[illegible] (26.67%)	[illegible]	[illegible]	0 (0)	[illegible] (26.67%)	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B Fish	2 (1)	Frequency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C Fowl	[illegible]	Frequency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
D Eggs	[illegible]	Frequency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
E Dairy products	[illegible]	Frequency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F Vegetables	[illegible]	Frequency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
G Fruits	[illegible]	Frequency	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Percentage	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Rank order	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Numbers within the parentheses represent the quantitative data of the experimental group from which cases II, III and VIII, who had only three weekly food records instead of five, have been excluded.

TABLE 7 - (Continued)

Foods	Total frequency	Frequency, percentage of frequency, and rank order	Type of Cuisine						
			1	2	3	4	5	6	7
3 Cereal Products	125 (139)	Frequency	24 (26)	24 (26)	27 (29)	9 (10)	25 (27)	12 (13)	4 (4)
		Percentage	19.20 (18.71)	19.20 (17.99)	21.60 (20.86)	7.20 (6.47)	20.00 (18.00)	9.60 (8.63)	3.20 (2.88)
		Rank order	3 (3)	3 (3)	2 (2)	6 (6)	4 (4)	5 (5)	7 (7)
4 Food combinations	55 (58)	Frequency	6 (6)	7 (7)	12 (12)	3 (3)	4 (4)	3 (3)	3 (3)
		Percentage	10.91 (10.34)	12.73 (12.07)	21.82 (20.69)	5.45 (5.17)	7.27 (6.90)	5.45 (5.17)	5.45 (5.17)
		Rank order	5 (5)	4 (4)	1 (1)	6 (6)	4 (4)	6 (6)	6 (6)
5 Custards, puddings and related desserts	36 (37)	Frequency	4 (4)	5 (5)	11 (11)	1 (1)	3 (3)	3 (3)	3 (3)
		Percentage	11.11 (10.81)	13.89 (13.51)	30.56 (29.73)	2.78 (2.70)	8.33 (8.11)	8.33 (8.11)	8.33 (8.11)
		Rank order	7 (7)	6 (6)	2 (2)	8 (8)	7 (7)	7 (7)	7 (7)
6 Concentrated sweets	10 (10)	Frequency	0 (0)	2 (2)	3 (3)	0 (0)	0 (0)	1 (1)	2 (2)
		Percentage	0 (0)	20.00 (20.00)	30.00 (30.00)	0 (0)	0 (0)	10.00 (10.00)	20.00 (20.00)
		Rank order	9 (9)	5 (5)	1 (1)	9 (9)	9 (9)	8 (8)	5 (5)
7 Pharmaceutics	4 (4)	Frequency	1 (1)	1 (1)	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)
		Percentage	25.00 (25.00)	25.00 (25.00)	50.00 (50.00)	0 (0)	0 (0)	0 (0)	0 (0)
		Rank order	8 (8)	8 (8)	1 (1)	10 (10)	10 (10)	9 (9)	9 (9)
8 Miscellaneous	8 (8)	Frequency	3 (3)	2 (2)	3 (3)	0 (0)	0 (0)	0 (0)	1 (1)
		Percentage	37.50 (37.50)	25.00 (25.00)	37.50 (37.50)	0 (0)	0 (0)	0 (0)	12.50 (12.50)
		Rank order	1 (1)	3 (3)	1 (1)	5 (5)	5 (5)	5 (5)	2 (2)

a. Table 6 presents in quantitative terms the result of the analysis of affective concomitant data on the basis of these 7 types of learning. All the foods consumed are treated here as one combined unit. The following are the outstanding facts shown in this table:

(1) When the experimental group was taken as a whole, Type 3 was the commonest type of learning. The other 6 learning types, arranged in the descending order of frequency, are: (2) Type 2, (3) Type 1, (4) Type 6, (5) Type 5, (6) Type 7, and (7) Type 4.

(2) Excluding Cases II, III, and VIII, because of their incomplete data, does not alter the order of frequency of the 7 learning types, although the exact percentages of frequency are somewhat changed. In general, the exclusion seems to cause a slight decrease in the percentages of frequency of positive types of learning (i.e., 1 and 3), and a slight increase in the percentages of frequency of negative types of learning (i.e., 2 and 4).

(3) When all the 8 subjects were considered individually in regard to the 7 types of learning, it was found that Type 3 was the most predominant type of learning with all the children except Case VII whose prevailing type of learning was Type 2.

(4) Type 4 was the least common type of learning with 6 of the 8 subjects. With the two remaining subjects Type 4 was one of the less common types of learning.

(5) As regards Type 1, the subjects were evenly divided. With half of the children it was the third most frequent; with the other half it was second in the descending order of frequency.

(6) Individual differences were very pronounced with regard to the order of frequency of Types 2, 5, 6, and 7, especially 6.

b. Table 7 gives the result of a more detailed treatment of the same data presented in Table 6. These data have been analyzed under the 13 major food divisions. The following are the principal facts presented in this table:

(1) When all the 8 subjects were considered as a whole, Type 3 was the commonest type of learning in 10 of the 13 major food divisions. When Cases II, III, and VIII were excluded from the group, Type 3 was the commonest type of learning in 7 of the 13 major food divisions.

(2) Type 2 was the commonest type of learning with the eight-subject group in the case of vegetables. When Cases II, III, and VIII were excluded from the group, Type 2 was the prevailing learning type in meats, vegetables, fruits, and food

combinations.

(3) Whether the three cases were included in or excluded from the group, Type 1 remained among the most predominant types of learning in the case of eggs and miscellaneous food items.

(4) Type 4 was nonexistent in 9 of the 13 major food divisions and least frequent in the remaining 4. No major food division was disliked by the children as a group throughout the experimental period. This was true whether the group was composed of 8 subjects or 5.

(5) Type 7 was nonexistent in 6 of the 13 major food divisions, and least common or among the least common in 4.

(6) Type 5 was nonexistent in 7 of the 13 major food divisions and among the least frequent in 2.

Both (5) and (6) applied to the experimental group as a whole, whether the group consisted of 8 or 5 subjects.

(7) Type 6 was nonexistent in 5 major food divisions when the experimental group consisted of all the 8 subjects. (If Cases II, III, and VIII are excluded, the number is increased to 6.) It was the least common or among the least common in 4 major food divisions.

III. Physical status

Data on the heights and weights of the subjects are recorded in Table 8. The range for the group was from plus 20 percent to minus 13 percent with an average deviation from the average weight of plus 2 percent. All the weights of 4 of the 8 subjects were on or above the average for their height and age with only one weight, recorded for Case IV, more than 8 percent below the average. This subject gained weight during the following 3 months so that at the second weighing she was only 5 percent underweight.

The parts of the dental and pediatric examinations related to the nutritional status of the subjects are recorded in Table 9. No caries or discoloration of the teeth was reported. The soft tissue around the teeth of Case VI was found to be in only fair condition, whereas, that of each of the other subjects was good. Cases III and VI had poor occlusion. The indifferent piddling at the table by Case VI was ascribed to this condition. The interdental spaces were rated as fair or poor for the majority of the subjects at the various examinations. Out of the entire 21 ratings, 6 were poor, 10 fair, and only 5 good. Poor shape and size of the dental arch, therefore, appears to be the outstanding dental defect.

The general physical condition of all the subjects was con-

TABLE *

HEIGHT, WEIGHT, AND LEVEL OF AVERAGE WEIGHT FOR SUBJECTS RECORDED AT THREE-MONTH INTERVALS

Case	Sex	Age		Height		Weight		Average weight for height and age	Deviation from average weight
		yr.	mo.	in.	cm.	lb.	kg.	lb.	%
I	F	2	2	32.7	83.1	26.0	11.8	26	0
		2	5	33.2	84.3	28.0	12.6	26	+15
		2	8	34.4	87.4	30.2	13.7	26	+16
		2	11	34.6	87.9	31.5	14.2	29	+ 9
		3	2	35.8	90.8	32.2	14.6	30	+ 7
II	M	3	3	39.7	100.9	33.0	15.0	36	- 8
		3	6	40.5	102.9	33.5	15.2	36	- 7
		3	9	40.8	103.5	34.3	15.6	38	- 8
III	M	3	7	39.2	99.5	39.0	17.7	35	+11
		3	10	39.3	99.7	38.5	17.4	35	+10
		4	1	40.2	102.0	42.0	19.0	36	+ 7
IV	F	3	5	38.8	98.5	30.5	13.8	35	-13
		3	7	39.2	99.4	33.1	15.0	35	- 5
		3	10	39.8	101.0	34.6	15.7	36	- 4
		4	1	40.2	102.8	35.6	16.1	38	- 6
		4	5	41.8	106.1	37.4	16.9	39	- 4
V	F	3	3	36.7	93.2	33.0	15.0	32	+ 3
		3	6	37.0	94.0	32.7	15.3	31	+ 5
		3	8	37.7	95.8	36.4	16.5	33	+10
		3	11	38.6	97.9	36.0	16.7	35	+ 5
		4	3	39.3	99.8	38.3	17.3	35	+ 9
VI	M	3	4	39.3	99.8	33.0	15.0	35	- 6
		3	7	39.6	100.6	34.7	15.7	36	- 4
		3	10	40.2	102.1	36.0	16.3	36	0
		4	0	41.1	104.4	38.0	17.2	38	0
		4	4	41.8	106.2	37.6	17.0	39	- 4
VII	M	3	6	41.5	105.3	37.0	16.8	39	- 5
		3	9	41.6	105.7	38.9	17.6	39	0
		4	0	42.4	107.7	39.0	17.7	39	0
		4	2	43.2	109.7	40.4	18.3	41	- 1
		4	6	44.6	113.3	42.0	19.0	45	- 7
VIII	M	3	3	40.0	101.5	40.0	20.0	36	+11
		3	6	39.8	101.1	39.2	17.7	36	+ 9
		3	9	40.2	102.1	43.1	19.5	36	+20

*From table prepared by Robert M. Woodbury given in Hoag, M.S. Feeding the Family, Macmillan, New York, 1940.

sidered good or excellent according to the evaluation by the pediatrician. The only abnormalities reported were those of slightly inflamed tonsils in 4 examinations and an anemic condition ranging from "quite severe" to "slight" in 10 examinations. Laboratory analyses showed a slightly anemic condition to be more or less prevalent, since of 21 examinations

TABLE 3

RESULTS OF BLOOD TESTS AND DENTAL EXAMINATIONS

Case	Sex	Age	Blood tests				Dental examinations	
			Hemoglobin	Erythrocytes	Leucocytes	Color index	Interdental spaces	Occlusion
		yr.-mo.	%	no./cu. mm.	no./cu. mm.			
I	F	2 3	72	3,850,000	7,650	0.90	good	good
		2 9	72	4,340,000	7,750*	0.83	fair-good	good
		3 7	84	4,380,000	11,350	0.90	fair	good
II	M	3 3	80	4,150,000	11,450*	0.98	poor	good
		3 9	86	4,300,000	7,400	1.00	fair	fair
III	M	3 8	55	3,940,000	4,200	0.70	good	poor
		4 2	78	4,280,000	6,600	0.90	good	poor
IV	F	3 5	70	4,220,000	7,000	0.89	fair-good	good
		3 11	80	4,300,000	9,250	0.90	poor	good
		4 8	80	4,270,000	9,150	0.90	fair-good	good
V	F	3 3	72	4,000,000	10,900	0.90	fair	good
		3 9	74	4,740,000	6,350	0.88	fair	good
		4 6	77	4,300,000	8,200	0.90	poor	good
VI	M	3 4	70	3,790,000	6,750	0.90	poor	poor
		3 10	72	3,830,000	4,850*	0.90	fair	poor
		4 7	74	3,860,000	7,850	0.90	fair	poor
VII	M	3 6	72	3,800,000	6,700	0.90	poor	good
		4 0	74	4,080,000	5,250	0.90	good	good
		4 10	75	4,200,000	9,000	0.90	good	good
VIII	M	3 4	70	3,090,000	6,100	0.80	poor	good
		3 9	80	4,480,000	8,200*	0.90	fair	fair-good

*Slight infection of tonsils reported by pediatrician.

15 showed hemoglobin levels to be below 78 percent, with one examination for Case III giving a result of 55 percent, and no examination giving results above 86 percent. The hemoglobin level of 86 percent was reached only by Case II who had been receiving iron concentrate. In the five-month interval between examinations the hemoglobin level of Case III was raised from 55 to 78 percent by incorporating iron rich foods in the diet as is shown by his iron intake in Table 1.

For the erythrocyte count, 7 examinations showed values below 4,000,000 erythrocytes, the lowest number being 3,090,000. The results indicate that a slight deficiency of the hemoglobin in the cells was prevalent among the subjects.

In the case of leucocyte count 5 examinations gave values above 9,000, the highest being 19,900. The high leucocyte counts coincided with tonsil infection in but one case. In all the other cases the high count is unexplained.

The results of these pediatric examinations neither indicate

drastic physical defects on the part of the subjects nor give a picture of buoyant health. Of the 8 subjects, Cases III and VI were the lowest in physical stamina, but the group as a whole might easily be considered healthy normal children.

Discussion

The subjects who received dietary supplements in the form of mineral and vitamin concentrates tremendously exceeded the dietary standard for those nutrients. Although the intake of massive doses of vitamins A and D and of iron are not harmful according to existing experimental findings, the doses probably are not effective in proportion to their quantity. No subject received a vitamin A-D preparation continuously throughout the year, although this practice is frequently recommended for children so young. The question arises as to the comparative affectiveness of massive doses of nutrients given sporadically and of moderate doses given in amounts commensurate with the recommended dietary standard regularly throughout the year. Dietary supplements, as these pharmaceutics are referred to, should be used to add to, but not to constitute the major portion of, a nutrient in a diet. The supplements given to these subjects were greatly out of proportion, in most instances, to the dietary needs of the individual.

The consumption of individual nutrients more nearly meets the recommended dietary standards than does that of the consumption of the food groups themselves. This may mean that the calculation of nutritive content of the foods has been too liberal, or that the dietary standard in terms of food groups is too generous. Certain probable errors occur, however, in many dietary studies because of variations in the nutrient composition of foods.

Calculation of nutritive value of foods from values given in tables on average compositions allows neither for deviations of a specific food produced in a given locality from the averages nor for possible losses of nutritive value during preparation. Average preparation losses are allowed for by the compositions given by Taylor (1), since most foods are listed as edible portion raw or cooked. Significant losses may occur from the most casual preparation processes such as peeling or coring an apple. Probable solution losses may occur where amounts of water used in cooking and the subsequent use of these "pot liquors" are not considered, as well as in the length of time a food is in water either soaking or cooking, the size and shape of pieces, whether peeled or unpeeled, and many other factors contributing to losses. Loss of vitamins by decomposition during cooking processes has been under investigation and the

detrimental effects of alkali, air, heat, and light are already established.

These many causes for the possible loss of nutrients from a fresh raw food produce deviations from average compositions given in tables, and are a disadvantage when calculating the nutritive value of a food rather than when determining the nutritive content by bioassay and chemical analysis. Complete chemical analysis, which at times must be checked by bioassay methods, is a long specialized process for which trained personnel and proper equipment are not always available. An experimenter is thus compelled to rely on calculations based on average compositions reported in the literature and compiled in tables in order to obtain an answer to the question of what the nutritive value of a diet is. In interpreting the data obtained by calculations, one realizes that the answer is probably only an average of a range of possible amounts of nutrients in a diet; therefore, one does not magnify the significance of small deviations from a dietary standard.

Standards for the amounts of foods which a person should consume in a given period of time are usually given in weights as purchased. Yet when one singles an individual out of a family and determines the amounts of food he consumes, one is forced to list mostly edible portions. For foods as milk, eggs, cereal products, and the like little difference exists between the quantity as purchased and the edible portion; but for fruits and vegetables there is a greater difference. One must keep this in mind when interpreting the adequacy of the amounts of fruits and vegetables consumed by these subjects. Differences in amounts between "as purchased" and "edible portion" would seldom be much more than 50 percent and for many fruits and vegetables they would be smaller.

Even when allowances were made for losses in the weight of the food during preparation, a drastic deficiency was found to exist for all subjects in the consumption of vegetables, especially green and yellow vegetables. The gravity of the situation is even more keenly appreciated when a careful examination of the affective concomitant records showed first, that the subjects liked vegetables least of all the 13 major food divisions; second, that negative learning was the most predominant type of learning in the case of vegetables; and third, that leaves were the most disliked of all the edible portions of green and yellow vegetables. In view of the fact that vegetables constitute one of the most important sources for a number of essential nutrients, coupled with the knowledge that the unfavorable reaction of the subjects toward vegetables probably mirrored the attitude of the general public, it would seem that mothers and nurses of

very young children should attempt at once to remedy this deplorable situation by the following methods. First, they might introduce more effective means of training their children to like vegetables when they are still infants. Second, they might render vegetable dishes more palatable by more diversified and improved methods of preparation. One of the incidental findings, reported earlier in this study, that beef cooked with vegetables was more acceptable to the subjects than that cooked by itself, may serve as a valuable lead to more interesting methods of preparing vegetables for young children.

Food consumption records further show that 7 of the 8 subjects ate an inadequate number of eggs. This deficiency was indeed unnecessary when both group and individual affective concomitant records indicate clearly that, with the possible exception of Cases IV and VI who disliked eggs prepared in certain ways, all the children liked eggs, and were, furthermore, learning to become more and more fond of them during the experimental year.

That 6 subjects did not consume sufficient amounts of potatoes was equally surprising when, as is evidenced by the affective concomitant records, they liked both sweet and white potatoes.

The rank score of 1.91 for fluid milk signifies that the affective concomitant for milk was definitely pleasant; therefore, the finding that no subject met the liberal allowance of one quart per day was without sound reason.

According to the affective concomitant records, non-citrus fruits, except prunes, were well liked. That 6 of the 8 subjects were reported in the food consumption data not to have consumed an adequate amount of non-citrus fruits, at least not enough to make up for the deficiency they had created in the consumption of the other fruit and vegetable group, was unwarranted.

Citrus fruits, on the contrary, were consumed in quantities well above the standard. This high consumption rate coincides with the findings of other dietary surveys made in this area; namely, those of Drake and Lamb (3) and Lamb and Corrington (4).

Affective concomitant records give consistent and conclusive evidence that children preferred refined to whole-grain cereal products, highly sweetened food items to unsweetened ones, and meats to vegetables. These findings should show those whose responsibility it is to train young children in sound dietary practices where to lay the proper emphasis in planning menus for their children. Since it is apparently the general tendency for young children to like refined cereal products because of the texture, highly sweetened foods because of the taste, and meats because of the flavor, should the training not be in the direction

of cheerful acceptance of whole-grain cereal products, unsweetened food items and vegetables as essential components of the dietary? Such can be done if the training is given early and judiciously.

It is interesting to note from affective concomitant data that, with both refined and whole-grain cereals, the subjects preferred ready-to-eat to cooked varieties. From the point of view of the amounts of nutrients per unit volume, cooked cereals far exceed ready-to-eat ones. Since it is the general practice of American housewives to measure the amount of food to be consumed by volume than by any other means, it will be a wise policy to encourage the children to eat cooked cereals at least as often as ready-to-eat varieties.

One of the most significant findings in the present study is the subjects' unanimous and strong fondness for fish. In consideration of the availability, digestibility, low cost, and high nutritive value of this major food division, it will be a sound policy that fish be included more frequently in the young child's diet.

By analyzing the affective concomitant data on the basis of learning, 7 different types of learning have been found. That Type 3 ("constant pleasant learning") was the most predominant of all types with the subjects in food consumption corroborates an earlier finding, based on the analysis of the affective concomitant data from the standpoint of preference, that eating was a pleasurable occupation to the children. From these results it would seem that by the time the young child reaches the nursery school age, he has already learned to enjoy a wide range of food, and his nursery school years are employed largely to consolidate his food preference.

Type 4 ("constant neutral or unpleasant learning"), on the contrary, was the least common type of learning with all the subjects in food consumption. This negative finding not only substantiates the positive discovery discussed in the preceding paragraph, but it likewise reveals a fortunate situation. For what would adults do, if by the time a child reaches the age of 2, 3, or 4, he has not yet learned to enjoy an occupation which he must confront at least three times a day?

Type 2 ("negative learning") was the predominant type of learning in the case of vegetables. Type 1 ("positive learning") was among the predominant types of learning in the case of eggs. Since we have already treated in some detail the significance of these two types of learning in vegetable and egg consumption respectively, we shall not discuss them further here.

Types 5 ("fickle learning"), 6 ("negative positive learning"), and 7 ("positive negative learning") were very uncommon types

of learning with all the subjects in food consumption. This is, in a way, fortunate, because all these three types of learning are more complex and, therefore, less predictable. For mothers and nurses who have to feed preschool children three or four times a day, their task is immeasurably lightened when the food likes and dislikes of these young people can be easily detected and predicted.

Even though these children were of normal health, some physical deficiencies were present in the group. Among these deficiencies was an anemic condition ranging from slight to severe. This condition in the subject paralleled a low iron intake. Imperfect dental development, resulting in poor occlusion and improper tooth arrangement, was also frequently recorded. That this is the result of improper diet during pre- and postnatal stages of development has been shown by Price (5). These are further evidences that the early diet of these subjects was not markedly deficient and yet not optimum.

Several subjects did not consume the recommended number of calories. Since their gains in weight for their height and age were normal from one experimental week to another, their calorie intake must have been adequate for their energy expenditure.

When these three sets of data, food consumption, affective concomitant, and physical status, were viewed as an interrelated whole, one sees the 8 children, participating in the present study, as typical of the community which they represented. From the layman's standpoint, they were normal in health, cheerful in disposition, and well-fed. However, when their food habits were carefully studied and physical conditions periodically checked, there is still much that can be done to improve their dietary practice in order to bring their physical well-being to an optimum.

SUMMARY AND CONCLUSIONS

This study investigates the food consumption and preferences of the preschool child. Eight children from the Nursery School of Texas Technological College, ranging in age from 2 years, 2 months to 3 years, 7 months, served as subjects. The study lasted one year during which food consumption and food preference records were taken simultaneously for one week at three-month intervals. Heights and weights were recorded at the beginning of each of these experimental weeks. Pediatric and dental examinations were given at the beginning, in the middle, and at the conclusion of the experimental period. These physical status records were taken to serve as a guide in the

determination of the nutritional status of the subjects.

From the results of this study, which consisted of both quantitative and qualitative data, the following general conclusions have been drawn:

1. By comparing the food consumption records gathered in this study with established standards it has been found that although the nutrient intake of a child may be generally adequate, his consumption of certain food groups can still fall short of the recommended amounts.

2. The preschool child has learned to like a wide variety of foods by the time he reaches the nursery school age and to regard eating as a pleasurable occupation.

3. As the preschool child grows older, intensely pleasant and unpleasant types of affective concomitant during food intake give way to more moderate types, and food consumption becomes a more matter-of-fact affair.

4. Preschool children of this locality have a tendency to like green and yellow vegetables least of all major food divisions, and to increase this lack of interest with age.

5. At least 7 types of learning have been found in the food consumption of the preschool child with positive types predominant.

6. Frequently inadequacy in the amounts and kinds of food consumed can be traced to faulty meal planning on the part of the responsible adult rather than to a lack of positive liking of the child for these foods.

7. When food consumption, food preference, and physical status records of the so-called normal and healthy children are simultaneously taken and analyzed, it becomes apparent that there is still much that can be done by way of improving their dietary practices in order to insure their optimum health and development.

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EFFECT OF FATHER SEPARATION ON PRESCHOOL CHILDREN'S DOLL PLAY AGGRESSION[1]

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The factors that influence anger and aggression in young children are but imperfectly understood. While frustration may be assumed to be an antecedent condition (3), the variety of direction and form is so great that a number of other variables besides the frustration itself must be taken into account if specific instances of aggression are to become interpretable. This is particularly evident in the fantasied aggressions of projective doll play. As early as the third year, children show marked individual differences in both kind and amount (1), and by the fourth year sharp divergence between the sexes can be observed (8). These variations represent fairly consistent characteristics of individual children (4), but the life history experiences that create them have not been charted.

From a systematic standpoint, fantasied aggression may be considered as part of a hierarchy of aggressive actions arising from either temporary or chronic frustrations. What specific actions form this hierarchy depend on a number of things - the severity of the frustration, the availability of the frustrating agent, the inhibitions created by social controls, the repertory of motives or action systems with which the child is equipped, the amounts and kinds of rewards or punishments anticipated for each kind of potential reaction to the frustration, and so on. In general it has been assumed (3, pp. 44-46) that fantasied aggression is most likely to occur spontaneously when the various controlling factors are decisively weighted against a direct overt aggressive act. In other words, fantasy is relatively low in the hierarchy, and only when more direct methods are inhibited is it chosen.

In the doll play situation these same principles are operative, even though the fantasy is not spontaneous in the same sense. The play materials are designed to provide positive instigation toward fantasy action; it is not necessary to rely only on the elimination of all other competing action systems. The doll family and home serve to instigate "home actions," and the procedure on the part of the experimenter is designed to reduce

[1] *Reported in brief by the senior author at the Meeting of the Society for Research in Child Development at St. Louis, March 29, 1946.*

social inhibition of the related aggression. Consequently, this is expressed with a greater freedom than it would be if no such materials were available.

This interpretation of fantasy still leaves unexamined the relationship between the content of "real-life" and fantasied aggressive acts. From a clinical standpoint, it would be diagnostically useful to know the extent to which, and under what conditions, the two are similar. Levy (5) and others have hypothesized that, because the doll environment more or less duplicates the real home environment, there is instigation to fantasied acts having the same content, at least as to agent and object, as real-life acts. The kinds of aggression differ radically in the two types of act; Robinson (9) has shown that the great majority of fantasied aggressions are of a sort that by no stretch of imagination could be expected in the real-life interactions of a normal family. It may well be that kind is simply an expression of intensity, that children have a hierarchy of symbols which are no more than step intervals on a continuum from weak to strong aggression. For example, having the child doll say "no" to the mother doll might be a weak aggressive act (for one particular child), while his frying the mother doll on the stove or stuffing her down the toilet might be a stronger one. This whole set of problems, involving response-response (10) relationships, needs exploration.

A different kind of problem, but one that also arises from the systematic interpretation of fantasy, is that of stimulus-response relationships. If the child's hierarchy of aggressive acts contains fantasy aggression, the question must be raised as to what factors in the instigating situation determine the specific kinds and amounts.

Studies by Bach (1) and Yarrow (11) have examined the effects of prior frustrations, and Bach (2) has more recently studied the effect on school-age children's fantasies of the absence of the father from the home and the variations in kind of father-typing provided by the mother during his absence. In this latter study it was shown that the role the father played in the home, and the mother's attitudes toward him, were significant variables in determining the kinds of fantasied actions by the child in the post-departure period. For example, children whose mothers were antagonistic toward or contemptuous of the fathers showed more aggression toward the father doll than did children whose mothers were affectionate toward and were longing for the absent father.

The present study has employed this same family situation - father absence - with preschool age children, in order to secure further information on the role of the father in the fantasied

aggression of his child. In order to evaluate this situation as an instigator, some consideration must be given to the kinds of socially oriented motivational systems in the activation of which the father is important.

Among the most important of these is sex-typing. From birth the child is allocated to one sex or the other, and society begins to implant in him the motives, interests, skills, and attitudes appropriate to such membership. The learning process by which he develops these action systems depends, among other things, on the existence of models upon whose behavior he may pattern his own. For a boy child, the father is often the chief model. Further, there must be someone available who has a sound knowledge (not necessarily verbalized) of what constitutes the right and wrong sex-typed behavior. This is essential in order that a continuous rewarding and punishing of such actions may reinforce or extinguish them.

Since society is composed of two main sexes, children must also learn how to behave toward each. The girl must have opportunity to react to, to be motivated by, and develop skills of social interaction with adult males. She must not only become a "girl" herself, but must learn what men are like and how to live with them. The same may be said for the boy; he must become not only a "boy" but a proficient understander of and interactor with men. For this kind of learning, involving discriminations and cues that are largely unverbalized; only actual practice opportunities are of value.

It would be an over-simplification to suppose that the father's only function was to serve as a model for or interactor with his children. He is an integral part of a social complex involving his wife as well. Each member of the family acts as an instigator to special forms of behavior in the others. He is also the effective agent for rewards and punishments, and the human "tool" used for securing many satisfactions based on secondary motives of a social character. To withdraw any member of this group is to frustrate all such dependent action systems. Subtle but important emotional dependencies are destroyed; accustomed responses disappear; cooperative arrangements for child-rearing, sexual satisfactions, intellectual interstimulation, and maintenance of social status in the family's relations with other families are all interrupted.

One could catalogue almost ad infinitum the modifications in the total pattern of instigation acting on the child which occur when the father (or mother) leaves the home. In every instance there must necessarily be some frustration, and in many there are alleviations of unsatisfactory relationships. No algebraic summing of these advantages and disadvantages can represent the effect on the family members, for each person's behavior

is composed of multiple action systems and the ultimate consequences of interruption or facilitation are to some degree specific to each system.

The absence of the father from the home is a simple event only from the sociological standpoint. Strictly speaking, the instigation created by it is unique for each family and for each member of the family. However, the similarities of family life in a given culture may provide for some similarity in the effects of the event. The role of the father in the sex-typing aspect of child-training, for instance, may prove to be fairly uniform. He is nearly always a model and his masculine characteristics ordinarily seem to include greater aggressiveness and greater tolerance for the social expression of aggression than do the feminine characteristics of the woman (cf. Mead, 6).

The data of the present study are descriptive accounts of the aggression shown in two twenty-minute periods of doll play by 126 nursery school children, 66 boys and 60 girls. Half the children of each sex were from homes from which the father was absent, in most instances in military service. The data were collected between February and May, 1945. The analysis has been directed toward a discovery of uniformities in the children's reactions to the changed instigation consequent on their father's absence, the main emphasis being placed on relationships that appear to be connected with the sex-typing process.

Method

Subjects. The children used as subjects were of preschool age and all were enrolled in wartime Day Care Centers. There were 22 boys at each of three age levels, 3, 4, and 5 years, and 20 girls similarly distributed. Within each age and sex group, half the children were from homes from which the father was absent. There were, therefore, four main groups:

boys: father present (N = 33)
boys: father absent (N = 33)
girls: father present (N = 30)
girls: father absent (N = 30)

Each of these groups was composed of an equal number of children (11 boys or 10 girls) within each age bracket; they were matched by age in months.

The Day Care Centers provided all day care, six days a week, for the children of working mothers only. The 12 Centers were located in Des Moines, Cedar Rapids and Davenport, Iowa, and Rock Island, Illinois. Twenty-four of the boys and 25 of the girls were only children. For both father and mother of both sexes, the median grade of school (reported) completed was the twelfth.

Materials. The doll play equipment[2] consisted of furnishings for a six-room house, including a living room, dining room, kitchen, two bedrooms, and a bathroom. The miniature furniture was proportional to the size of the dolls used, and was realistic and colorful in appearance. When presented to the child, the materials were organized to represent a conventional house, with beaver board walls indicating the boundaries of the house and the location of the various rooms. When organized, the set measured 32 inches in length and 25 inches in width. However, none of the equipment was stationery; walls and furniture could be reorganized as the child wished. The dolls were placed in a row before the house.

Dolls representing a mother, father, preschool-aged boy and girl, and a baby, were used. The adult dolls were approximately 5 1/2 inches in height, the boy and girl, 3 1/2 inches, and the baby, 1 1/2 inches. The dolls were lifelike in appearance and dressed in suitable clothes.

Procedure. Each subject received two twenty-minute sessions of doll play. Usually these sessions were presented on consecutive days, though in nine instances one day elapsed between sessions.

When the subject was brought into the room, the materials were in view on the floor. The experimenter (M.H.P.) led the child over to them, and sat down on the floor with him in front of the set. The experimenter then said, "See all the toys I have - here's a whole house, isn't it?" Each room was named and pointed out to the subject, and then the experimenter said, "Now, here are the people who live in the house - here's the mother, the father, the little girl, the little boy, and the baby. You can make them do anything you want. You go ahead and play with them any way you like." Scoring was then begun and continued for 20 consecutive minutes.

If the subject asked the experimenter what she was writing on the paper, the experimenter said, "I'm just keeping track of the dolls and furniture this way. I keep track of the time, too" (gesturing toward stopwatch). Then she attempted to get the subject to return to the experimental task by saying, "What's going to happen next? What do they do?" and looked expectantly at the materials.

After the child began to play with the equipment, the experimenter's role was that of a very interested onlooker. The kind and amount of interaction between experimenter and child was maintained at the high level, as defined by Pintler (7). This consisted of 15 to 20 interactions with the child during each

[2] *Cf. Robinson (9) for a more detailed description.*

five-minute period. At no time did the experimenter suggest any specific doll actions or ask for or give interpretations, though by her encouraging remarks and continued attention to the child's play, she conveyed her interest and enthusiasm for what the child was doing.

At the end of the twenty-minute session, the experimenter said, "That was fine! You really know how to do it. Now, our time is up for today, but maybe you'll have another turn later."

Scoring and Categories. In addition to conducting the doll play session, the experimenter recorded all instances of aggression. Aggressive acts were defined as those having the intent to injure, punish, destroy, or generally disparage and depreciate. If a doll character was described as having an aggressive-hostile nature, attitude, or mood, such descriptions were recorded as aggressive units. The doll characters, the equipment, the experimenter, or the experimental room might be involved in the aggression.

By the use of symbols and arrows, the characters involved in any aggressive act as initiators or recipients of the aggression were indicated. In addition, a brief description of the nature of the aggressive act was recorded. For this purpose, the following symbols were used.

M	mother	O	generalized catastrophes such as storms, bombings, etc., and imaginary characters such as witches, Indians, wolves, rats, etc.
F	father		
B	boy		
G	girl		
bb	baby		
s	subject		
e	experimenter	→	direction of aggression
eq	equipment		

The following notation, for example, means that the boy doll was fighting and pushing the girl doll. The aggression was being expressed by the boy toward the girl.

B → G		fighting, pushing

Other illustrative examples are as follows:

M →	B	puts him to bed (The mother doll punishes the boy doll, for something he had done, by putting him to bed)
O →		storm blows house over (An imaginary evil and aggres-

		sive agent, the storm, destroys or injures something; no <u>personal</u> recipient indicated)
O	→ B	storm drowns him (Similar, but one of the dolls is the recipient)
F	→	"he's mad!" (A quotation by one of the other dolls; indicates the presence of hostility in the father doll)
S	→ F	"I don't like him." (The subject showed a hostile attitude toward the father doll)
S	→ eq	knocks over all the furniture (Tangential aggression)
O	→ e	subject in role of wolf, "I'm going to eat you up." (Aggression at a fantasy level, but directed toward the experimenter)
G	→	jumps on piano, table, chair (An outburst of aggressive behavior by the girl doll)
M	→ F	"Why don't you make those children behave?"
	→ M	"She's gotten sick." (A comment by the subject, but no indication of a specific agent of the sickness)
	→ bb	jammed down toilet (Subject may have been initiator, but not entirely clear from context; possibly another doll did it)
MF	→ BGbb	simultaneously jump on children who are piled on floor.

An aggressive act (or acts) was considered as one unit until some relevant change in person or method of expressing aggression was noted, or a definite break in the sequence of aggression occurred. For example, if the boy doll hit the girl again and again it was recorded as one unit. If he then picked up a chair and threw it at her, a new unit of aggression was recorded since the method of expressing the aggression had changed, although the person remained the same. If the boy and

girl were fighting and hitting each other, two units of aggression having different initiators and recipients were recorded. If this interchange of hitting continued, no new units of aggression were recorded, since the same method of aggressive action was continuing and the directions of it had been indicated for each doll involved.

If a definite break in a sequence of aggression was noted, such as cessation of the aggression for several seconds, the performance of an unaggressive doll act, organization of the materials, or conversation with the experimenter, and then the same sequence of aggression was resumed, it was recorded as a new unit.

Verbal aggression which served to illustrate or elaborate an aggressive act which was occurring was not scored separately. However, if there was no behavioral expression of the aggression which was being verbally expressed, then the verbal aggression was scored as a unit.

All aggression during the doll play sessions, irrespective of its mode of expression, can be considered as originating in the subject and being initiated by him. But in the scoring system, a distinction was made between that type of aggression which came directly from the subject and was directed to the dolls, equipment, or the experimenter without any known story component, and that which was expressed through the medium of the doll characters.

Only such acts of aggression as biting or twisting the dolls, pounding them with a piece of the furniture, a comment by the subject such as "I don't like that doll," or hitting the furniture or experimenter, were scored as aggression direct from the subject. Where any story component to the aggression could be recognized, the subject was not indicated as the initiator of the aggression. In such instances, the doll characters who initiated or received the aggression were recorded if it was possible to identify them, and if it was not possible to identify the initiator, then only the recipient was indicated.

In general, a unit of aggression was recorded for each doll involved, but where, as a group, two or more dolls were used in a concerted aggressive attack of a physical nature against another doll or dolls, the equipment, or experimenter, this was recorded as a group action.

In addition to the aggressive acts themselves, a record was kept of the time at which aggression first occurred and of the amount of interaction between experimenter and child. The end of each five minute period of the session was also indicated.

Reliability. To determine the reliability of this method of recording, two observers independently scored all aggressive

acts during 18 half-hour periods of doll play. Approximately 460 units of aggression were recorded during this time. Each session was conducted by M. H. P., who also recorded; the other observer sat behind a one-way screen, or in the same room at some distance from the child, and scored independently.

Both boys and girls were used in this reliability group, and their ages covered the range from three to six years.

Reliability was computed by means of percentage of agreement between the two observers; the formula is:

$$\frac{2 \times \text{No. of Agreements of A and B}}{\text{Total of A + Total of B}}$$

In order to constitute an agreement, not only the same content of the aggressive act had to be recorded by the two observers, but also the exact direction of the aggression in terms of initiator and recipient.

Reliabilities for these 18 sessions ranged from .0 to 1.00. The extremes were found in those sessions in which very few instances of aggression occurred. Total reliability was .82.

Results

Frequency of aggression

One measure of the strength of instigation to aggression is the frequency with which such acts occur spontaneously. Since the father's absence from the home represents a direct frustration to the child and a source of strain for the mother, and hence an additional though indirect possibility of mother — child frustrations, it might be anticipated that the father-absent children would show more frequent aggression in their doll play than the father-present children.

The relevant findings are presented in Table 1. Data for boys and girls are separated, since it has been shown (8) that average frequency for girls is much less than for boys.

Table 1. Mean frequency of total aggression by all boys and all girls with father present or absent, together with differences between groups.

Father Status	Boys			Girls			Diff.	C.R.	L. of C.
	N	Mean	S.D.	N	Mean	S.D.			
Father present	33	29.0	24.9	30	8.1	11.2	21.8	4.6	< 1%
Father absent	33	18.2	22.1	30	9.6	10.1	8.6	2.0	5%
Difference		11.7			1.5				
Critical Ratio		2.0			.5				
L. of C.		5%			N.S.				

Clearly, the prediction is not substantiated. The girls from the father-present and father-absent groups did not differ significantly, and the boys showed the exact opposite of the predicted relationship - the father-absent group was less frequently aggressive than the father-present.

In view of the many other consequences of father-separation, it is evidently an over-simplification to interpret the fatherless home as merely frustrating and to expect a gross increase in aggression. Two hypotheses suggest themselves. The first relates to inhibition of aggression, by the mother, and the second to a delay and distortion in the sex-typing process.

Inhibition hypothesis

On the whole, girls are less aggressive both in doll play and in real life than are boys. If this difference continues into adulthood, and it is a popular supposition that it does, it would be expected that mothers are less tolerant of aggressive behavior than fathers. Not only would they provide little encouragement for it, but they would suppress it to some degree. It is hypothetically possible, therefore, that boys whose primary training was coming from women (mothers and teachers) would develop an inhibition of aggressive behavior. This would be reflected in the doll play as a lowered mean frequency of aggression in the group of boys with fathers absent.

Another consequence of such inhibition would relate to its release in doll play. It has been shown repeatedly (1, 4, 11) that lack of restraint by the experimenter leads the child to become more aggressive from session to session. If there were an unusual degree of inhibition in the father-absent group of boys, then, it would be expected that they would show a greater increase than the father-present group from first to second session.

Table 2. Mean frequency of aggression in first and second 20 minute sessions.

Father Status	Session I	Session II	C.R.	L. of C.
Boys				
Father present	11.4	10.5	4.6	$< 1\%$
Father absent	7.9	10.5	1.4	$> 10\%$
Girls				
Father present	2.6	5.5	2.6	$> 1\%$
Father absent	4.5	5.1	0.6	60%

In Table 2 are given the mean frequencies for all four groups in both sessions, and the significance of the differences. The results are entirely contrary to the prediction. For both sexes,

the father-present group have an increase in frequency of aggression at the second session that is reliable near the 1 percent level of confidence, while for neither of the father-absent groups is there a change having much of any significance.

These differences gain in importance if the data for each age are examined separately. In Table 3 are given the relevant levels of confidence. At both the early ages, the father-present group of boys show a very reliable increase; at five years the difference is less reliable but in the same direction. The father-present girls do not show significant increases when the small numbers of cases at each age level are considered separately.

Table 3. Reliabilities of differences in frequency of aggression between first and second sessions. All changes were increases except those marked with asterisk (*).

	Boys		Girls	
Age	Father-present	Father-absent	Father-present	Father-absent
3	$\leq$ 1%	$>$ 50%*	5%	$>$ 20%
4	$\leq$ 1%	$>$ 20%	$>$ 20%	$>$ 10%*
5	$>$ 5%	10%	20%	$>$ 20%

This test of the hypothesis is not entirely critical, since it is conceivable that the inhibition was so strong that two twenty-minute sessions were insufficient to release it materially. The strength of inhibition would be determined by the characteristics of this situation as a learning situation; whether it would give rise to weak or strong inhibitions is a question that cannot be answered. It is interesting to note, nevertheless, that Jeffre (4) found relatively little increase in aggression, with a normal preschool population of above-average intelligence, after the second of four half-hour sessions. Provisionally, it would seem safest to conclude that, at least, there is no evidence in favor of the inhibition hypothesis.

Sex-typing hypothesis

The second possible interpretation of the lower mean frequency for the father-absent group relates to sex-typing. As has been suggested earlier, the father serves as one of the most important models for the young boy. Without his father in the home, a youngster must model his behavior after his mother and other persons who enter his orbit. This does not mean that a boy of three is forced entirely into feminine sex-typing, for one has but to examine the daily environment of any urban youngster to see that many others besides his parents can influence him. The younger ages, however, are more lim-

ited in their social contacts outside the home, and at best there is a delay in the child's opportunity to develop the sex-typing that would be going on continuously from birth if both parents were in the home.

According to this view, then, it would be expected that at the earlier ages sex differences would be less clearly established in children whose fathers were absent than in those whose fathers were in the home. The father-absent boys should be less aggressive than the father-present boys; the two groups of girls should not differ significantly from one another, however.

In Figure 1 are shown the mean frequencies of aggression for each of the three age groups, divided as to sex and fathers' status. The sex differences between boys and girls whose fathers were in the home are reliable at better than the 1 percent level of confidence in both the three- and four-year-old groups and at a little greater than the 5 percent level in the five-year-old. The relationships with the fathers out of the home are notably different, however. There is no sex difference at three years, an unreliable one favoring the boys at four years, and a larger one (2 percent l. of c.) in the same direction at five years.

None of the differences between adjacent age groups in any of the four groups is reliable, although an upward tendency for the boys of the father-absent group is apparently indicated. The difference between three and five years is significant only to the 10 percent level, however.

These findings follow reasonably well the predictions made from the sex-typing hypothesis: where the father is absent, in the earliest year (three) there is no sex difference comparable to that in children from normal homes, but the difference develops in the fourth and fifth years. Furthermore, the two groups of girls do not differ significantly from one another, while the father-absent boys are less aggressive than the father-present boys at both earlier years (l. of c. only 10 percent and >10 percent) but approximately equal by the fifth year. It is interesting to note, too, that the increase in frequency from first to second session, which was characteristic of the father-present boys, appears to be developing in the father-absent boys (Table 3); there was an insignificant decrease at three years, an insignificant increase at four, and an increase with 10 percent level of confidence at five. These changes are of little import by themselves, but the direction of change with age is similar to the changes occurring in total (2-session) frequency - that is, toward a similarity to the father-present boys.

These findings give some support to the interpretation in terms of sex-typing. The group differences are ones that might

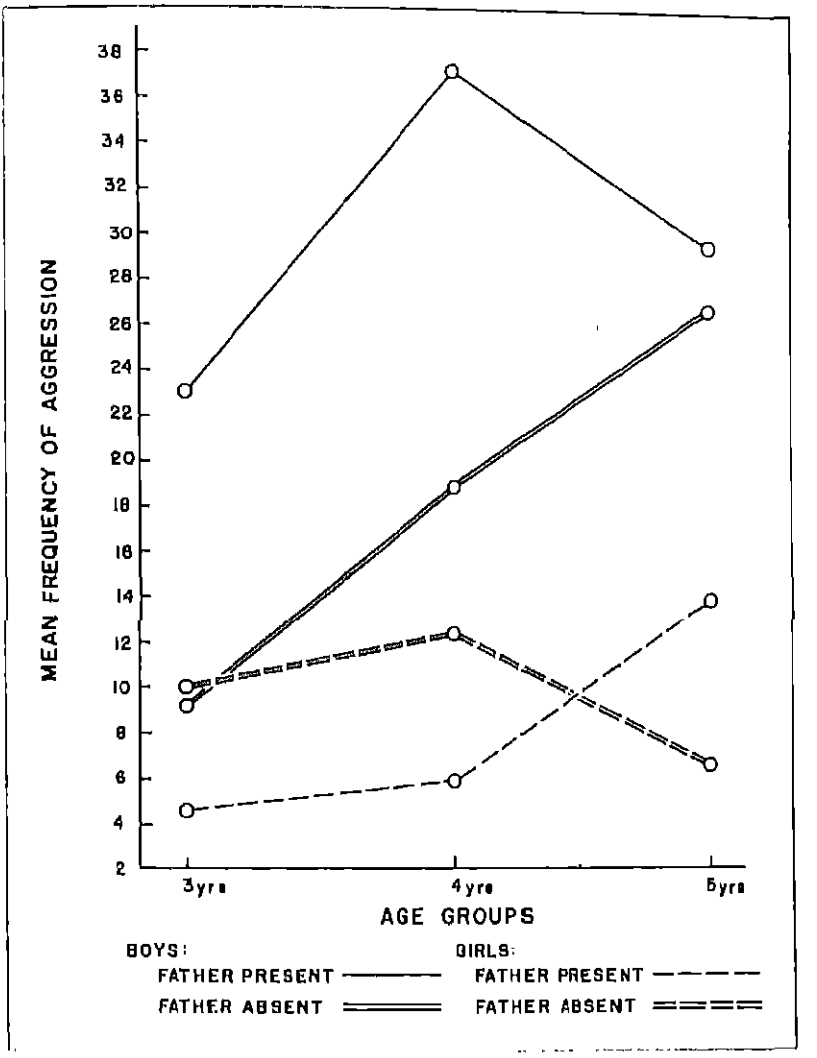

Figure 1. Total aggression. Mean frequency of total aggression by each sex with father present or absent.

be expected if the father serves as a model and a monitor for the son, providing a sample of greater aggressiveness than is found in the mother's behavior, and perhaps countenancing more overt aggression. When he is absent, the mother provides the chief learning experiences in these matters.

There are other aspects of the doll play, however, that must be examined before any very certain conclusion about these interpretations can be reached. For example, it is not immediately evident just what influence sex-typing or its distortion might have on the direction of fantasied aggression. Yet the identity of the person represented as agent or recipient of aggression must involve facts of considerable importance concerning the child's attitudes and his experiences with his family. The next section, therefore, presents an analysis of the data on direction, and is followed by a discussion of the sources of frustration which might account for the findings.

Direction of aggression

As was emphasized earlier, the absence of the father creates a different set of interpersonal relations within the family. The mother must necessarily take over some of the father's functions, inept though she may be because of her own sex-typing as a woman. Furthermore, she must play her own role without the supportive behavior of a husband. The complexity of the interactive behavior between a husband and wife is so great that it would be impossible, without an empirical approach, to hazard guesses as to the exact nature of the frustrations and gratifications that occur in either the presence or the absence of one member of the pair. It would be little more than idle speculation to try genuinely to "predict" the effects on children's fantasy behavior.

It is possible, however, that the opposite method of reasoning can be of value, that is, that the comparison of directions of doll play aggression by children living under these two contrasting conditions may suggest some of the functions the father serves. At least, such data can reveal who, on the average, are the most frequent agents of aggression in the child's experience, and toward whom he has the most frequently effective instigation to fantasy aggression.

Boys. In Table 4 are given the average frequencies, for the two groups of boys, of aggression expressed by and toward each of the dolls and other possible initiators or recipients. Subject refers to the child himself; O-catastrophes refers to wolves, ghosts, storms or other imaginary items; group of dolls refers to more than one doll used at a time.

In every instance, the frequency was lower for the father-

Table 4. Boys: mean frequency of the use of each doll or other agent as an initiator or recipient of aggression.

	Father present N = 33	Father absent N = 33	Diff.	C.R.	L. of C.
Initiators					
Subject	0.94	0.94	0	0	
O-catastrophes	2.24	1.70	0.54	0.87	
Mother	2.61	1.36	1.25	1.61	
Father	2.82	1.58	1.24	1.47	
Boy	2.70	1.21	1.49	1.93	5%
Girl	2.06	1.00	1.06	2.04	5%
Baby	1.12	0.88	0.24	0.55	
Group of dolls	0.18	0.09	0.09	0	
Recipients					
Subject	0.06	0	0.06	0	
O-catastrophes	0.61	0.18	0.43	1.13	
Mother	3.64	3.36	0.28	0.19	
Father	4.82	3.09	1.73	0.97	
Boy	4.64	1.67	2.97	3.61	<1%
Girl	3.42	1.55	1.87	2.26	2%
Baby	3.12	1.64	1.48	1.71	
Group of dolls	0.97	0.55	0.42	1.35	
Experimenter	0.06	0	0.06	0	
Equipment	1.91	1.09	0.82	0.85	

absent group, but these differences were by no means of equal size. In four of the 18 items the difference was great enough to give a 5 percent or better level of confidence. All four relate to the boy and girl dolls; both as initiators and recipients they were used less frequently by the father-absent group.

The implications of this rather curious finding become more apparent when the data are examined for each age group separately. In Figure 2 are shown the average frequencies of the mother, father and boy dolls used as recipients. The girl doll has not been plotted because the frequency does not vary a great deal from age to age for either group.[3]

It is evident that the massing of the ages, as in Table 4, hides some important variations. At age three, there is little or no difference among the dolls for either group, although the two groups are well separated, with the father-absent group lower than the father-present. By five years, however, the position has been reversed for the mother doll; in the father-absent group she is the highest recipient, and in the father-

[3] *Values for the girl doll as recipient are as follows:*

	3 yrs.	*4 yrs.*	*5 yrs.*
Father present	*3.2*	*4.0*	*3.0*
Father absent	*1.1*	*1.2*	*2.4*

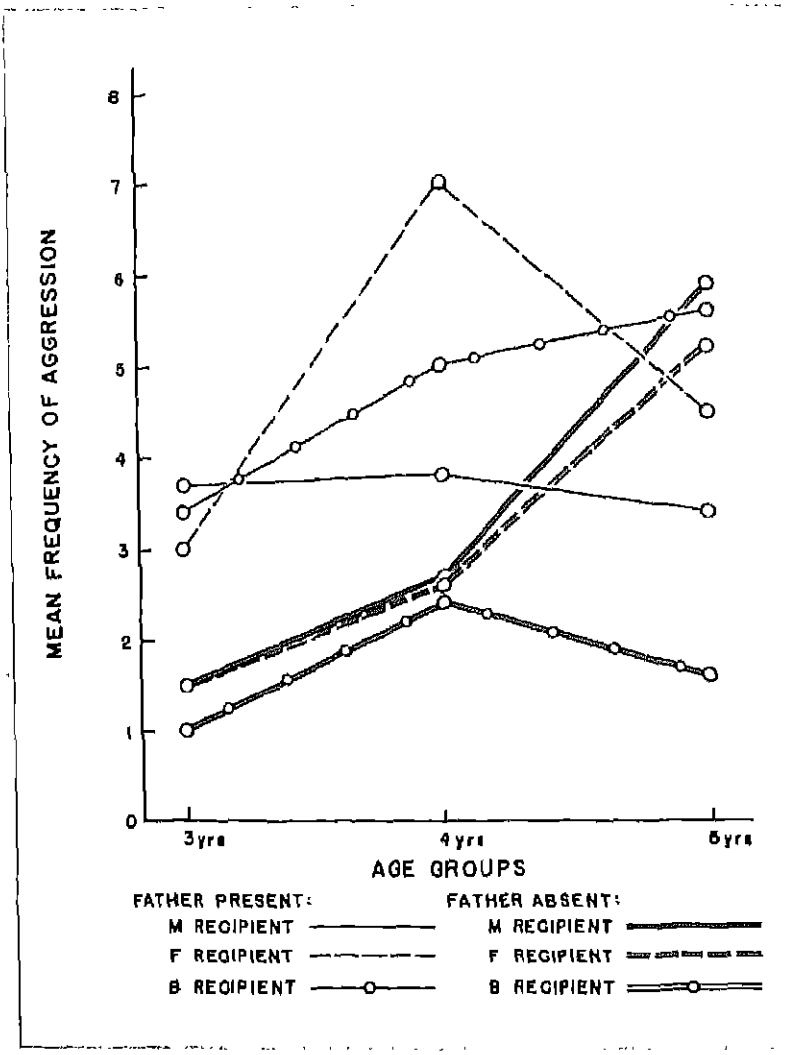

Figure 2. Boys: recipients of aggression. Mean frequency of mother, father and boy doll as recipients of aggression by boys with father present or absent.

present group she is the lowest. The increased use of the mother doll from the three to the five year level, in the father-absent group, is significant at the 5 percent level. There is practically no change with age in the father-present group.

The frequency of using the father doll as a recipient follows an age curve similar to that of the mother in the father-absent group, but goes to a much higher level at four years in the father-present group. Neither the differences between the two groups at individual ages nor the increase from three to five years in the father-absent group are significant at better than the 10 percent level, however.

The two groups differ considerably, also, in the frequency with which the boy doll is used as a recipient. This is especially apparent when a comparison is made of the trend with age. In the father-absent group, the parent dolls increase in frequency from three to five years, while the boy doll stays the same. In the father-present group, the mother doll stays the same and the boy doll rises; the father doll also rises at four years but drops down somewhat at five. The boy doll difference between the two groups at the five year level is significant between the

Table 5. Girls: mean frequency of the use of each doll or other agent as an initiator or recipient of aggression.

	Father present N = 30	Father absent N = 30	Diff.	C.R.
Initiators				
Subject	0.17	0.63	0.47	1.73
O-catastrophes	0.30	0.40	0.10	0.27
Mother	0.83	0.83	0	0
Father	0.83	0.53	0.30	0.80
Boy	0.70	0.53	0.17	0.51
Girl	0.83	0.50	0.33	0.94
Baby	0.67	0.47	0.40	0.90
Group of dolls	0.13	0.03	0.10	0.77
Recipients				
Subject	0	0.07	0.07	0
O-catastrophes	0	0	0	0
Mother	0.93	1.40	0.47	1.15
Father	0.77	1.30	0.53	1.08
Boy	0.67	1.37	0.70	1.59
Girl	1.23	1.30	0.07	0.13
Baby	1.57	0.37	1.20	1.90
Group of dolls	0.17	0.37	0.20	0.71
Experimenter	0.07	0	0.07	0
Equipment	0.07	0.46	0.39	0.33

2 percent and 5 percent levels of confidence, and the change in relative position of the boy and mother dolls, from ages three to five, is significant at much better than the 1 percent level of confidence.[4]

The possible implications of these age changes will be considered in the discussion below.

Girls. In Table 5 are given the mean frequencies of each initiator and recipient for the two groups of girls. In no instance is there a significant difference between the groups. Again the analysis of recipients by age groups shows some interesting trends, although the total number of aggressions was so small, and the zero scores so frequent, that none of the differences between groups at a given age or between ages of a given group has statistical significance.

Figure 3 shows the average frequencies of mother and father dolls as recipients, and Figure 4 shows the boy and girl dolls. It appears that none of these recipient frequencies is entirely independent of age. Unlike the boys, however, the girls had greater variability among the dolls at three years and, with the exception of the boy doll in the father-absent group, all the dolls are approximately equal for both groups at five years. This trend is consistent at the four year level for seven of the eight curves.

Discussion

The father's role. The data of this study are limited to aggression and hence do not give a complete picture of the children's fantasies about home life. Within the limits so imposed, however, certain facts emerge that have some importance for an understanding of the role the father plays, both when he is present in the home and when he is absent.

It seems evident that during the preschool years he contributes heavily toward the sex-typing of boys in respect to their expression of aggression. How he does this remains to be discovered. Probably he serves as a model, a more aggressive model than the mother. Possibly, too, he provides a more permissive environment for aggression. In any case, his absence leads to a reduction in the frequency of such actions in doll play,

[4] *This statistic was obtained by a t-test of the difference between the two groups with respect to the frequency-of-boy minus frequency-of-mother in the five year groups. Of the 11 boys of the father-absent group, only one had more boy- than mother-recipient instances, and of the 11 boys in the father-present group, only one had more mother- than boy-recipient instances.*

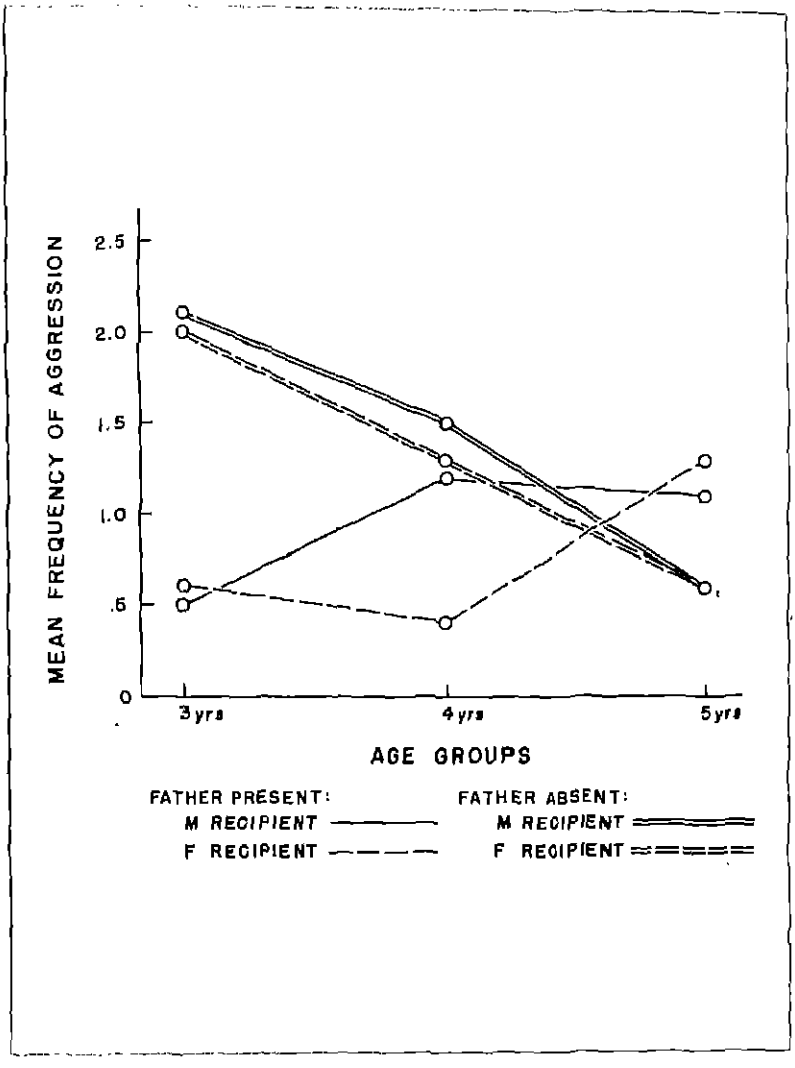

Figure 3. Girls: recipients of aggression. Mean frequency of mother and father dolls as recipients of aggression by girls with father present or absent.

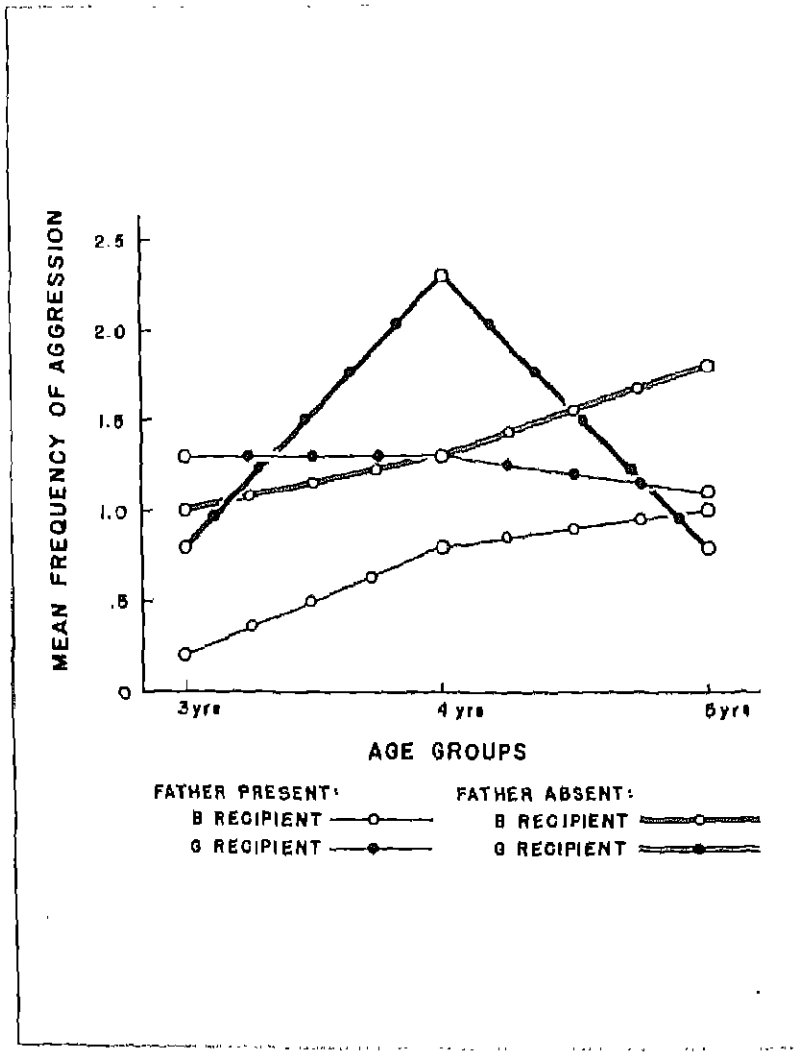

Figure 4. Girls: recipients of aggression. Mean frequency of boy and girl dolls as recipients of aggression by girls with father present or absent.

and there is no evidence that this results from any special suppression by the mother. Further substantiation of this reasoning comes from the decreasing effect of father-absence as the children get out into more social contacts (i.e., the older they are).

When the data on recipients of aggression are examined, however, still another factor seems to be introduced. The father's greater aggressiveness apparently operates as a frustration, at least to his son. The reason for thinking this is that when the father is absent, the boy shows equal aggression toward both parent dolls; when he is present, there is greater aggression toward the father doll than toward the mother. Furthermore, there is a strong suggestion that the father exercises a more rigid control over the boy than does the mother; with the father present, boys express a very marked aggression toward the boy doll, while his absence is associated with very low boy doll aggression. The high boy doll aggression may well represent *self-aggression*, which is a likely *consequence of too strict* paternal control (cf. Levy, 5, p. 199). It appears, then, that the father serves not only as a model but also as a frustrator whose control over the son leads the boy to fantasied self-aggression as well as to father-directed aggression. In the absence of the father, this self-aggression is not prominent, but both parents share equally in direct aggression which reaches its peak at five years.

Two other aspects of the data suggest that this father-frustration may be related to the emotional developments commonly discussed in connection with the Oedipus situation. First, the relations described above are most pronounced during the fourth and fifth years. The younger boy does not react with differential amounts of aggression toward the two parents, but as he gets older and more aggressive, he comes into more conflict with his father. The sources of such conflict may be various. If the father is serving as a model, the son will imitate him, and the father, possibly feeling guilty about his own aggression, will punish his son's aggressions. From a purely mechanical standpoint, the boy's increased aggressive behavior will be bound to impinge more and more frequently on the father, frustrating the latter more often, and thus elicit greater counter-aggression. The fact that the father is more permissive of aggression than the mother does not mean he is more tolerant of aggression directed toward himself; he is, if anything, less tolerant. But he is permissive with respect to the use of aggression as a solution of social conflict in the neighborhood, at school, and among siblings or animals in the home. Another possible source of conflict may be an increasing competition of the son with his father,

an Oedipus competition, but in the absence of evidence from the home itself, such an interpretation must remain purely hypothetical. It is interesting to note that even in the father-absent group there is an increase in aggression toward the father at the fifth year; this is parallel to the increase for the mother. Unfortunately the measure of aggression used with these data (frequency) does not enable us to distinguish between aggression caused by increasing social control, and that which might, hypothetically, be caused by fantasied competition, from the absent father, for the mother's affection and attention. The same anonymity of source exists for the father-directed aggressions of the father-present group. In any case, the result of the increasing conflict is probably greater paternal control, which serves not only to frustrate the son but to redirect some of the boy's aggression toward himself. This is a behavioral consequence of the kind observed by Freud, and on the basis of which he posited the Oedipus pattern of development.

Second, there is no indication that the girls are more frustrated when the father is present; on the contrary, his absence is associated with greater aggression, especially self-aggression (girl doll) during the fourth year. The girl appears to develop without special conflict with her father. Possibly it is the mother with whom she comes in more serious conflict. In any case, the father's absence leaves her free to develop under the mother's guidance, and it is in his absence that she shows an increase in self-aggression. In general, the data suggest that the parent of the same sex provides the greater frustration and the more rigid control.

These interpretations coincide fairly well with what is commonly believed to be typical of father-son and father-daughter relationships. The phrase "commonly believed to be typical" is especially significant. There are no adequate objective data that report the "typical" in-family behavior to be found in upper lower and lower middle class homes. It is questionable whether a clearly definable modal form could be discovered. Each family has its own structure, its own dominances, social tensions, disciplinary forms, dependencies and other emotional relationships that finally determine the role each member plays and the frustrations or gratifications produced by his presence or absence. Only to the extent that cultural uniformities do exist can data such as those from the present study be expected to present invariable and consistent relationships.

Measurement of aggression. The interpretative approach of this study has been toward discovering not only the father's role in relation to his child but the nature of the child's aggressive motivational systems as they are influenced by the father.

This has led to conclusions couched in terms of an intervening variable, strength of instigation to aggression, the operational measure of which has been frequency of differentiable aggressive fantasies. Whether this measure is the most suitable for investigating the quantitative properties of aggression may be questioned, but whatever conclusion is reached, the assumptions underlying it deserve explicit statement.

It is supposed that a child possesses an unknown number of potential responses to each object with which he comes in contact. These make up his repertory of actions that can be elicited by the stimulus properties of the object. The member-responses of this repertory are of unequal strength and stability, however, and they form a hierarchy with respect to their probability of occurrence on any given presentation of the object. The origin of this hierarchical characteristic lies in a number of factors, such as frequency of previous reinforcements and number of facilitating drives or instigators operative at the moment of presentation.

It is further assumed that some of the responses in a given hierarchy are incompatible with one another, so that if one occurs certain others cannot. Whether the incompatibility is of central or peripheral origin makes no difference; the significant point is that there is a series of potential incompatible responses of different strength.

The measurement of strength of instigation by frequency of occurrence rests on the proposition that the stronger the drive, the more frequently will the drive-instigated response compete successfully with the other potential responses elicitable by the object. This proposition, in turn, rests on the assumption that each occurrence of a drive-instigated act reduces the immediate strength of that drive, and that successive reductions are cumulative in their effect. Hence, the drive strength is eventually reduced to a level at which it is less than that of other, coexisting, drives.

In the doll play situation, for example, the father doll may serve as a stimulus object. There are several potential reponses the child may make to him, affectionate approach, supplication, aggression, inquiry, and so on. Each of these actions is a member of the hierarchy. Each is repeatedly being instigated by the father doll. Since the experiment is designed to hold constant all other sources of instigation to each of these responses, only drive strength can vary, and hence determine which response occurs. Once any of the actions has occurred, there is again a free situation in which all have an equal chance. If the aggressive drive is high, the aggressive action will occur not only once but many times. If it is low, the partial reduction

in drive strength caused by the first few occurrences will have allowed the total strength of instigation to aggression to drop lower than the strength of instigation to one of the other actions. The repeated reductions in drive strength, resulting from occurrence of goal responses (fantasied aggressive acts, etc.), provide for fluctuation in drive strength. It is assumed that the greater the initial strength, the more acts will be required to reduce it to a point at which it competes unsuccessfully with other simultaneously operative drives.

Other possible measures that might be used are latency of first aggressive act, duration of actions, and type of action (cf. earlier discussion of kind as a measure of intensity). The logical support for these measures is more difficult to trace, however, and there are other psychological variables that are known to influence them to a considerable extent. For example, the degree of inhibition of aggression is important in determining latency. Duration is difficult to measure and is sensitive to momentary changes in the attitude of the experimenter. Too little is known about factors determining type of aggression to permit, at present, the construction of the necessary scale of seriousness that would reflect intensity.

SUMMARY

Two twenty-minute projective doll play sessions were secured from 126 children enrolled in Day Care Centers. The group was composed of 66 boys and 60 girls, each sex evenly distributed among three ages, three, four and five years. Half the children of each sex and age level were from homes in which the father was present, and half were from father-absent homes. Descriptions of all doll play aggressions were recorded. These data were analyzed, in terms of frequency, with reference to age and sex differences as these related to the presence or absence of the father. The following conclusions were reached:

1. Boys from father-absent homes portrayed much less fantasy aggression than boys from father-present homes.

2. Girls from father-absent homes portrayed slightly, but not reliably, more aggression than girls from father-present homes.

3. Neither boys nor girls from father-absent homes portrayed the customary sharp rise in aggression frequency on the second doll play occasion. The rise did occur in the father-present groups.

4. The direction of aggression toward the various members of the doll family indicated:

   a. greater aggression toward the father, by boys, when

he was present than when he was absent

b. greater aggression toward the father than toward the mother, by boys

c. greater aggression toward the boy doll, by boys, when the father was present than when he was absent

5. The findings have been interpreted in terms of sex-typing and the frustrating and rewarding roles of the parents in their home relationships with the children.

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A NOTE ON THE COMPARATIVE MOTOR ABILITY OF NEGRO AND WHITE TENTH GRADE GIRLS

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In a recent program of testing at an Oakland, California, high school, the Brace Test (1) of motor ability was given to all tenth grade girls who were physically able to participate at the time of testing. The Brace Test consists of a series of stunts of varying degrees of difficulty. It is designed to measure such aspects of general bodily coordination as agility, flexibility, balance, strength and control. The girls were tested in groups of 6 to 10 and all scoring and recording was done by the author.

The influx of Negroes into Oakland during the war has had a marked effect upon the school population. Of the tenth grade girls tested in the Fall of 1944, nearly one-third were Negro.[1] Although the total number of cases is small, the lack of studies (3) on the gross motor ability of Negroes made it seem worth while to report the results obtained.

Thirty-five Negro girls were matched with an equal number of white girls on the basis of age, weight and height. On the average, Negro girls in the tenth grade are a half year older than whites, weigh slightly less, and are approximately equal in height. (Table 1.) These results are in accord with those of other investigators (2, 4, 5) who report that the Negro tends toward a somewhat more slender build than the white. No difficulty was experienced in this study in pairing Negro with white girls for weight and height, but some 6 of the Negroes were older than any white girl in this grade.[2]

The average total score on the Brace Test for the whites was 11.37, for the Negroes, 10.65. This difference is not significant; the P value falls at the .70 level of confidence. An examination of the significance of the differences between the percentages of girls passing each test suggests that the whites tend to be superior in balance, while the Negroes show greater arm strength. (Table 2, Figure 1.) In only two tests, however, are differences significant at the .01 level of confidence: test 18, balance with eyes closed and test 17, a measure of leg

[1] *Any girl who had Negro blood and who was considered a member of the Negro social group was classed as Negro. No attempt was made to estimate the degree of racial purity of the subjects.*

[2]

$\frac{\text{Mean of differences, white-Negro}}{\text{Sigma of mean of differences}}$	*Age*	*P*
	.34	.73

strength, control and flexibility.

Of the Negro girls tested, 21 attended junior high school in the San Francisco Bay area or in Los Angeles and 14 had recently come from other states. As physical education programs differ markedly in different states, the performance of these two groups of Negroes was compared to determine possible effects of previous training. The mean Brace score for the California Negroes was 10.67, for the others, 10.64. Table 3 shows that each of the Negro groups tends to excel the other in a few tests but no differences are significant and no consistent pattern which might be attributed to any specific cause emerges. On two tests, differences between the Negro groups are as great as or greater than those between Negroes and whites.

The results indicate that white girls tend to be superior to Negro girls in balance. Since this conclusion rests upon a few measures, scored either "pass" or "fail" and hence of low reliability, it must be interpreted with caution. Further study is needed in this area.

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TABLE 1

AGE, WEIGHT AND HEIGHT OF NEGRO AND WHITE GIRLS

	No.	Age (years) Mean	S.D.	Weight (pounds) Mean	S.D.	Height (feet) Mean	S.D.
All Whites	70	15.3	.56	131.1	20.5	5.39	.43
Negroes	35	15.8	1.05	127.8	16.9	5.36	.42
Whites, matched cases	35	15.5	.55	127.6	17.0	5.38	.42

TABLE 2

SIGNIFICANCE OF THE DIFFERENCES BETWEEN PERFORMANCES OF NEGRO AND WHITE GIRLS ON CERTAIN BRACE TESTS

C R *	No. of Test **	Analysis of Test
2.50	18	Balance (eyes closed)
2.50	17	Leg strength, control, flexibility
1.75	7	Agility and balance
1.20	16	Agility and balance
1.03	20	Leg strength, control, flexibility
.85	8	Agility
.78	15	Agility and balance
-.62	19	Arm and shoulder girdle strength, flexibility, balance
-.81	9	Leg strength, control
-1.67	5	Arm and shoulder girdle strength, control
-1.78	10	Agility, flexibility

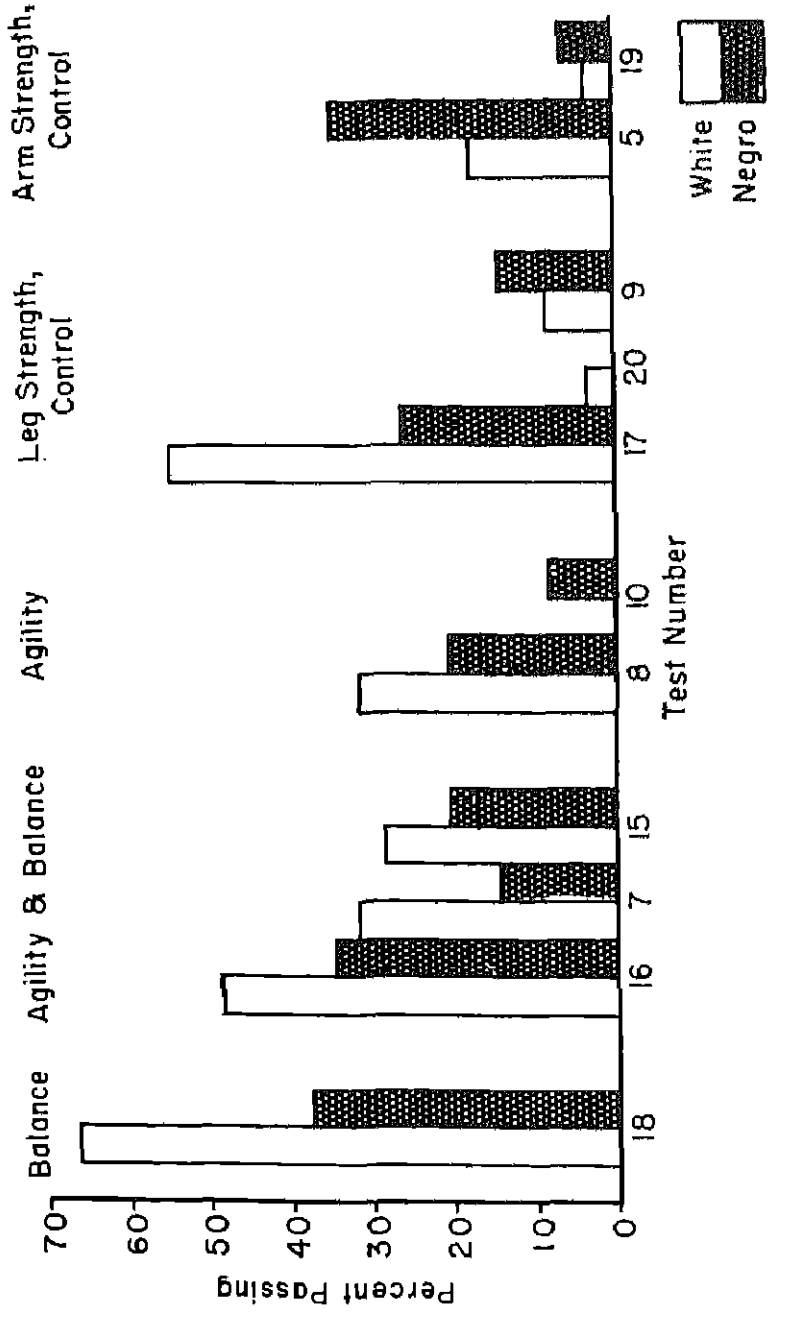
* Positive numerals indicate white superiority.
** All other tests were passed by more than two-thirds of both groups.

TABLE 3

SIGNIFICANCE OF THE DIFFERENCES BETWEEN CALIFORNIA AND NON-CALIFORNIA NEGRO GIRLS ON CERTAIN BRACE TESTS

C R *	No. of Test
-.92	18
-1.13	17
1.84	7
-.92	16
00	20
-1.07	8
.77	15
1.54	19
00	9
00	5
00	10

* Positive numerals indicate superiority of California Negroes.


Balance
Agility & Balance
Agility
Leg Strength, Control
Arm Strength, Control
Percent Passing
70
60
50
40
30
20
10
0
18
16
7
15
8
10
17
20
9
5
19
Test Number
White
Negro

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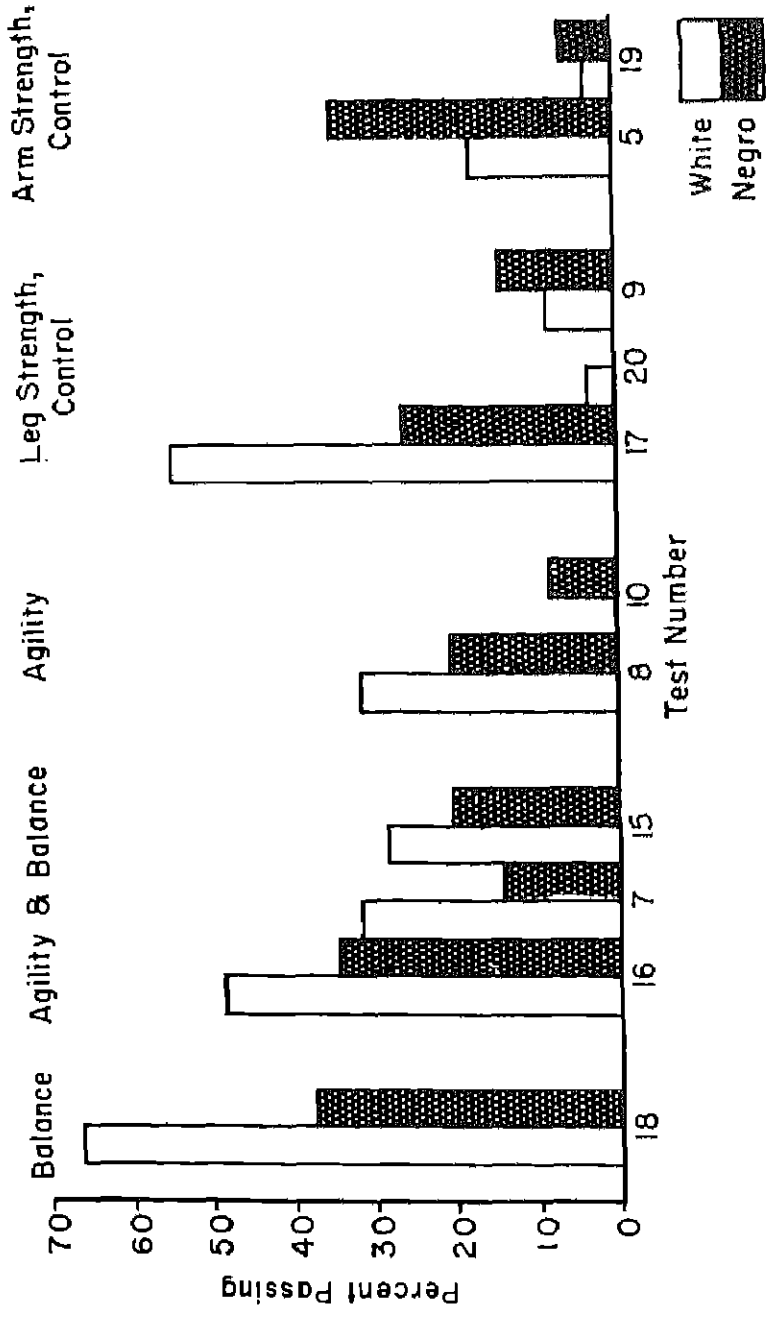
Note: Pagination for all other than first author is given in parentheses.


Balance
Agility & Balance
Agility
Leg Strength, Control
Arm Strength, Control
18
16
7
15
8
10
17
20
9
5
19
Test Number
White
Negro
Percent Passing
0
10
20
30
40
50
60
70

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